University of Otago

Department of Psychology

**RESEARCH THESIS**

A Comparative Analysis of Emotion Recognition: Young Versus Older Adults Across Gender and Cultures

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# ABSTRACT

The purpose of this research was to investigate emotion recognition in adults across age, gender and culture. Using the six basic emotions of anger, disgust, fear, happiness, sadness, and surprise as stimuli, the aim is to examine whether men and women benefit differently from eye and mouth gazing. Comparisons will be made, first, between male and female participants, second, between young and older adults and third, between Europeans and South-east Asian Chinese. The dependent measure will be correct responses to emotion recognition items. Six basic emotions were shown to 108 young adults ($M\approx20$ years) and 109 older adults ($M\approx70$ years) from European and Asian Chinese descent. The two-part experiment which consisted of a web-based survey and the use of an eye-tracker, was conducted in New Zealand (NZ) and Singapore (SG) with facilities provided by the Psychology departments of the University of Otago and the National University of Singapore respectively. I found age-related deficits across cultures and disparity in emotion recognition with NZ Europeans participants outperforming their south-east Asian Chinese counterparts in all emotion recognition tasks. While older women benefitted more from nose gazing, older men's mouth gazing was associated with *worse* emotion recognition. In addition, higher depression and loneliness, and lower well-being correlated with worse emotion recognition for younger adults.

A Comparative Analysis of Emotion Recognition: Young Versus Older Adults Across Gender and Cultures

## Introduction

The innate ability of humans to evoke facial expressions is generally accepted as an instinctive and biologically driven reaction to an emotional stimulus (Darwin & Prodger, 1998). Facial expressions are important for nonverbal communication as they indicate the emotional state of a person (Fasel & Luettin, 2003). Since each facial expression has a distinct facial patterning that is universally associated with a specific emotional state, the basic emotions of anger, fear, happiness, sadness, disgust, and surprise are cross-culturally distinguishable (Ekman & Friesen, 1971). However, emotion recognition should not be confused with facial expression recognition. Emotion recognition identifies the emotional state of the person, while facial expression recognition gleans visual information on facial motions and feature deformations. While facial expression might be generic, the inherent power to recognise emotional expressions is not universal. Meta-analyses on emotion recognition have shown facial expression processing (FEP) differences of age, gender and cross-cultural contact (Elfenbein & Ambady, 2002, 2003; McClure, 2000; Ruffman, Henry, Livingstone, & Phillips, 2008). Furthermore, previous research has demonstrated that older adults show age-related deficits when recognising negative emotions of anger, fear, and sadness. However, it remains unclear if poorer emotion recognition performance in older adults correlates with their gaze patterns. The purpose of this research was to investigate emotion recognition differences between young and older adults across gender and culture. Further, using the six basic emotions of anger, disgust, fear, happiness, sadness, and surprise as stimuli, I aimed to examine whether men and women benefit differently from eyes and mouth gazing.

**2) Gaze Patterns and Emotion Recognition**

There is a strong correlation between gaze patterns and the ability to recognise emotional expressions. People have a strong bias to attend to a scene containing a person, and particularly to the person within the scene (Fletcher-Watson, Findlay, Leekam, & Benson, 2008). The first fixation is usually on the body, possibly to ascertain the gender of the person but as fixation increases, the likelihood of focusing on the face increases. In social interaction, the information we glean from face gazing is crucial for understanding the intentions and emotional states of others. Emotional facial expression not only takes precedence over a neutral expression, but they are also seen more frequently and perceived longer than neutral expressions (Alpers & Gerdes, 2007).

While most healthy individuals are very competent in decoding emotional facial expressions, research shows that accuracy varies when recognising particular expressions such as happy and fearful expressions. For instance, in one study, neutral and happy faces were identified more accurately and in a shorter time than the other expressions (Calvo & Nummenmaa, 2009), whereas fearful expressions were identified least accurately and in a longer time (Calvo & Lundqvist, 2008). Moreover, there were systematic errors of misperception among the expressions, for instance, with sadness being inaccurately recognised as disgust or fear. Accuracy rate also decreased as the number of emotional expressions presented increased, in particular, surprised and fearful expressions were often misclassified, whereas anger was misperceived as disgust (and vice versa) (Calvo & Lundqvist, 2008).

The eyes and mouth regions are the regions carrying maximum emotion information. Eyes and mouths often attract more attention than other parts of the human face because they inform the observer of the mood of the other person (Yarbus, 1967). A meta-analysis study revealed that happy faces were more accurately and quicker to recognise than other emotion expressions (Nummenmaa & Calvo, 2015), whereas negative emotions such as sadness and fear were least accurately recognised (Mancini, Biolcati, Agnoli, Andrei, & Trombini, 2018). The stark difference in a healthy individual's ability to correctly decode emotional expressions is evident when compared with depressed, psychopathic, people with autism and schizophrenia, whose impairments in decoding expressions lie in their tendencies to avert looking at faces including the eyes and mouths (Hernandez et al., 2009). In general, healthy individuals tend to mainly focus on the eyes and mouth when looking at facial expressions. Previous research on tracking eye patterns showed a significant preference for the left eye with younger adults spending more time exploring the left eye than the older adults. These younger adults were also more likely to end their exploration on the eyes while the older adults tended to end their exploration on the nose (Birmingham, Svärd, Kanan, & Fischer, 2018). Apart from looking at the eyes, younger adults benefitted from increased fixation on the nose during emotion recognition tasks since subsequent successful emotion recognition was correlated with increased nose looking. However, this was not applicable for the older adults although they looked more at the nose overall (Firestone, Turk-Browne, & Ryan, 2007). One advantage of nose looking is that, to some extent at least, it can take in both eyes and mouth information simultaneously, which might be why it is correlated with better emotion recognition in young adults.

Researchers also found that scanning the upper or lower parts of the face impacted the accuracy of emotion recognition identification. Calder, Young, Keane, and Dean (2000) investigated whether looking at the upper or lower halves of facial expressions would affect emotion recognition. Results showed that by scanning the lower parts of the face, the identification of happiness and disgust was better. On the other hand, emotion recognition of sadness, fear, and anger, was better when one visually scanned the upper half of the face. The emotional expression of surprise was equally recognisable either from the bottom or the top sections of the face (Basili, 1979; Calder, Young, Keane, & Dean, 2000; Ebner & Johnson, 2009; Sullivan, Ruffman, & Hutton, 2007; Wong, Cronin-Golomb, & Neargarder, 2005).

Furthermore, depending on the emotional expression, the duration of fixation differed on the upper and lower regions of the face (Eisenbarth & Alpers, 2011). While individuals mostly fixated on the eye region in all emotional expressions, fixation was longer at the mouth region when gazing at happy facial expressions than fearful and sad faces. Conversely, the eye region was mostly fixated upon when gazing at angry and sad facial expressions.

Alternatively, impairments in decoding accuracy and gaze patterns might be caused by a deeper, underlying problem. For instance, they could be a result of deficiencies in brain regions also associated with emotion recognition. Functional imaging studies have shown the role of the amygdala in processing information about facial expressions such as fear, happiness and anger (Adams, Gordon, Baird, Ambady, & Kleck, 2003; Morris et al., 1996). Patients with amygdala deficits show impairment in recognising fearful expressions which could be a result of their inability to utilise information from the eye regions of faces when decoding emotions. Besides the amygdala, other studies have also implicated the orbitofrontal cortex (OFC) and the superior temporal sulcus as brain regions that process eyes information, with deficits in the amygdala and OFC inevitably affecting the recognition of fear and anger (Blair & Cipolotti, 2000; Calder, Lawrence, & Young, 2001).

### 1.1 Gaze Patterns: Age and Gender

Previous research has revealed age differences in gaze patterns. In an eye-tracking study by Firestone, Turk-Browne, and Ryan (2007), researchers found that participants looked longer at younger than older faces, looked longer at the mouths of younger than older faces and looked longer at the eyes of older than younger faces (Firestone, Turk-Browne, & Ryan, 2007). In addition to the effects of emotion expressed in faces, age of faces affected visual inspection of faces. Both young and older participants spent a longer duration looking at own-age than other-age faces. As a consequence, longer looking at own-age faces predicted better own-age expression identification (Ebner, He, & Johnson, 2011).

When completing tasks on emotion recognition, there is some evidence that older adults tend to focus on the lower part of the face and less on the eyes, whereas younger adults tend to focus on the eyes more than older adults (Murphy & Isaacowitz, 2010). As such, gaze patterns could be age-related, which has implications for how older adults fare in emotion recognition tasks, particularly on specific emotions.

Further, research shows that the allocation of attention to the upper or lower regions of the face differs between males and females. Using eye trackers, researchers found young females looked more at eyes than at mouths, when compared with younger males (Hall, Hutton, & Morgan, 2010). There was no difference for men and women in the overall number of fixations to the face, but women tended to fixate longer and more frequently on the eyes than men. Furthermore, for angry, surprised and happy facial expressions, women attended to the eyes first before looking at the mouth. The reverse was true for disgusted, sad or fearful facial expressions (Hall et al., 2010). These results further support the idea that eye gazing correlated with better performance since emotion recognition accuracy increased as women looked longer at the eyes than men.

More recently, researchers have found an interaction between age and gender in face looking (Sullivan, Campbell, Hutton, & Ruffman, 2017). Young men and women spend about the same percentage of time looking at eyes versus mouth. Subsequently, looking diverges in old age with older women increasing looking at eyes and older men increasing looking at mouths. This divergence might be caused by an implicit understanding of which regions benefit emotion recognition; both young and older men benefit from mouth looking (correlations with recognition of happiness/disgust), whereas both young and older women benefit from eyes looking (correlations with recognition of anger/sadness/fear).

A meta-analytic review of gender differences in facial expression processing (FEP) revealed that from infancy through to adolescence, females have an advantage in FEP over males (McClure, 2000). This gender difference could be partly biological in origin since studies revealed that even at one-day old, female infants showed a stronger interest than males in looking at a real person's face compared to a mobile made up of randomly interspersed photos of face bits (e.g., eyes, nose, mouth) (Connellan, Baron-Cohen, Wheelwright, Batki, & Ahluwalia, 2000). Also, early in infancy, female infants engaged in more mutual eye contact with adult caregivers than boys (Lutchmaya, Baron-Cohen, & Raggatt, 2002). Not surprisingly, the advantage at FEP continues into young and older adulthood (Ruffman, Murray, Halberstadt, & Taumoepeau, 2010).

### 1.2 Gaze patterns: Culture

In addition to these findings on age and gender differences, it is important to note that cognitive processing styles vary with different cultures. Researchers have found marked differences in decoding universal facial expressions between Western European and East Asians (Jack, Blais, Scheepers, Schyns, & Caldara, 2009). Using eye trackers to analyse eye movements of participants from different cultures, researchers found that East Asians exhibited a significant deficit in categorising emotional expressions of disgust and fear when compared with their Western counterparts. In another study comparing Western European and Japanese participants, researchers found that Western Europeans tended to adopt feature processing strategies (e.g., looking directly at face and eyes) when recognising emotion. In contrast, the Japanese tended to exhibit context-sensitivity in emotion recognition by not only focusing on the person expressing the emotion, but also spending more time looking at other people in the background (Masuda et al., 2008). This difference in attention influenced their interpretation of the intensity of the emotion they saw. In attending less to the face region, the Japanese might neglect the cues to the emotional expressions.

Another study compared the American and Chinese cultures and showed that both cultures exhibited context-sensitivity in emotion judgments but differences in the way they processed contextual information (Stanley, Zhang, Fung, & Isaacowitz, 2013). Western Europeans tended to use a more contrasting strategy where the target facial expression was compared with other facial expressions in the background while the Chinese used less of the contrasting strategy. The use of different strategies resulted in Western Europeans being more accurate in recognising emotions than the Chinese. In sum, cultural differences led to different gaze patterns and cognitive processing styles, which manifested in different accuracies of emotion recognition.

## 2. Emotion Recognition: Differences and Deficits

Any impairment in recognising emotions signifies an incapacity to predict and interpret the other person's emotional state and intentions, a potentially important limitation. For older adults, the problem becomes an important consideration since emotion recognition impairment has a negative impact on social integration which is associated with better health outcomes (Bath & Deeg, 2005). The primary mode of emotion perception is through the visual system which gathers emotional information. Through cognitive evaluation and interpretation, a label is then assigned to an emotional state. Hence, how accurately an emotional expression is recognised largely depends on how the emotion is perceived. While the ability to perceive emotion (i.e., see or hear it) is innate, the ability to accurately interpret the emotion is not only dependent on past experiences and interpretations but also the sensory systems that convert the observed emotional state into mental representations. These differences in emotion recognition, like gaze at emotion faces, are influenced by age, gender and culture (Elfenbein & Ambady, 2002; Nashiro, Sakaki, & Mather, 2012; Ruffman et al., 2008; Ruffman, Murray, Halberstadt, & Taumoepeau, 2010)

### 2.1 Emotion Recognition: Age Differences

To repeat, research showed that older adults demonstrate deficits in emotion recognition, particularly with negative emotions such as fear, anger, and sadness (Ruffman et al., 2008). More specifically, research suggests that even when older adults are restricted to focus only on the eyes, the difficulty in recognising negative emotions such as fear, anger, and sadness, persisted (Sullivan et al., 2007). However, this finding must remain only a suggestion because Sullivan et al. (2007) combined their task with a second task when examining significance, and did not test whether older adults were significantly worse when given the eyes only or the mouth only. Thus, an important unanswered question is whether older adults would do worse recognising emotion when given only the eyes or only the mouth, and also whether these regions present particular difficulties for men versus women (e.g., men struggling when given only the eyes, and women struggling when given only the mouth). I will examine this question in the proposed study. However, in this section, I consider some of the explanations for older adults' difficulties.

**Perceptual difficulties.** Given that gradual reduction in the acuity of vision is linked to aging (Caban, Lee, Gómez-Marín, Lam, & Zheng, 2005), age-related differences found in emotion recognition could also be linked to age-related visual sensory acuity loss. However, it does not seem to be the case that poorer emotion recognition performance in older adults is associated with an age-related decline in visual sensory processing skills or their gaze patterns because older adult eye gaze is corrected to normal through the use of eye glasses, they struggle more on some emotions (anger, sadness and fear) than others (surprise and happiness), and they even have a marginally significant advantage on disgust (Ruffman et al., 2008). Furthermore, they have difficulties with auditory expressions (Ruffman et al., 2008) even when they adjust the volume to be audible, and with bodily expressions (Ruffman et al., 2008) despite the fact that bodily expressions rely on gross movement of limbs rather than finer movement of facial muscles.

**General cognitive decline.** Another idea is that general cognitive decline may account for the age-related difficulties in recognising emotions. Although crystallised ability such as vocabulary is spared in aging, fluid ability, which is the ability to identify patterns, solve novel problems and rationalise new situations, is subject to age-related functional decline (Horn & Cattell, 1967). An extensive range of neural systems including the frontal and temporal systems are involved in emotion recognition, but the frontal lobes are central (Ruffman et al., 2008), and the frontal lobes are also integral to fluid ability (Kane & Engle, 2002). While research has demonstrated that more severe cases of neurodegenerative diseases are linked to impaired emotion recognition, research on milder and general cognitive decline having similar effects is still on-going. Some researchers demonstrated that cognitive decline might also relate to emotion recognition, citing evidence that poorer Mini-Mental State Examination scores (a test indicating early signs of dementia) correlate with emotion recognition impairment (Virtanen et al., 2017). More specifically, except for happiness which was less affected, poorer emotion recognition paralleled the deterioration of decline seen in healthy aging. Further, there is growing evidence that a progressive reduction in fear, sadness and anger recognition is related to the effects of increased age and aging brains regions (Calder et al., 2003; Elferink, van Tilborg, & Kessels, 2015; Malatesta, Izard, Culver, & Nicolich, 1987).

**Brain decline.** Some have argued that brain decline accounts for emotion recognition decline. Besides the frontal lobes, the amygdala and temporal lobes are also involved in emotion recognition. Historically, the amygdala has been implicated in the perception of emotional expressions such as fear (Adolphs, 2002; Adolphs & Tranel, 2004). Functional imaging studies have demonstrated that the amygdala is strongly activated with fearful and angry faces (Breiter et al., 1996). In recent years, however, the thinking has changed and researchers are stating that any intense expression including happiness will activate the amygdala (Adolphs, Baron-Cohen, & Tranel, 2002; Bonnet et al., 2015). Consistent with the idea that the amygdala is central to emotion recognition, deficits in emotion recognition have been found in patients with amygdala damage (Adolphs et al., 2005; Calder et al., 2000). Although the decline of the amygdala in older adults may not be as rapid as other brain areas such as the frontal lobes, linear reductions are still evident (Grieve, Clark, Williams, Peduto, & Gordon, 2005).

As stated above, the frontal and temporal lobes have also been implicated in emotion recognition decline (Ruffman et al., 2008), with both regions undergoing rapid volume declines in older adults. Furthermore, there is a decline in the level of neurotransmitters, which could also impair emotion recognition (see Ruffman et al., 2008 for summary). Thus, the difficulty in recognising anger, sadness, and fear could primarily be due to the decline of regions in the frontal lobes such as the orbitofrontal cortex or the cingulate cortex, or regions in the temporal lobes such as the amygdala. Conversely, the ability to recognise disgust could relate to the relative preservation of the basal ganglia.

### 2.2 Emotion Recognition: Sex Differences

Not only are there age differences in emotion recognition, but researchers have also found sex differences. In some studies, men and women are equal when full-blown expressions are shown, but men are more deficient in recognising subtle emotional expressions than women (Hoffmann, Kessler, Eppel, Rukavina, & Traue, 2010). In addition, females were faster and more accurate at recognising emotion expressions when subtle emotional information was given (Hoffman et al., 2010). Thus, it seems that the female advantage in emotion recognition can be clearly evinced when subtle expressions are used.

However, other studies have indicated that a clear female advantage is evident even when fully-blown expressions are used. This is true in a meta-analysis examining infancy through to adolescence (McClure, 2000), and in another study in older adults (Ruffman et al., 2010). This difference could be mediated by women paying more attention to the eyes and dwelling longer on the eye regions than the men. It follows that men's reduced looking at the eyes and older men's preference to look at mouths would impair their emotion recognition accuracy. However, at least one study indicates that men's looking at mouths does help them in that it correlates with recognition of happiness/disgust (Sullivan et al., 2017). To date, studies have only examined spontaneous looking preferences and recognition accuracy. However, a more systematic way of getting at this issue is to restrict an expression to just the eyes or just the mouth, and then examine gender differences in recognition. The question is whether recognition of negative emotions such as fear, disgust, anger, and sadness would be better for females than males when only the eye region is visible. Conversely, would recognition of happiness and disgust be better for males when only the mouth region is visible? I will examine this question with my study.

### 2.3 Emotion Recognition and Culture

Cross-cultural contact and geographical proximity also appear to affect how people recognise emotions. A meta-analysis of cross-cultural emotion recognition studies reportedly found that people are better at recognising emotions when the facial expressions are expressed by members of their cultural group (Elfenbein & Ambady, 2002). Much research on psychology to date was conducted by researchers who were from western, educated, industrialized, rich and democratic (WEIRD) societies. These researchers had assumed that other cultures share the basic affective and cognitive processes and that their research can be generalised to other populations. However, findings from various disciplines contradicted these assumptions and revealed variations in diverse domains such as visual perception or analytic reasoning (Henrich, Heine, & Norenzayan, 2010).

Cultural differences are evident in the way Asians gaze at faces and recognise emotions (Stanley et al., 2013). The way Westerners express emotions such as disgust and fear differs from that of East-Asians, particularly in the regions of eyes, eyebrows, and mouth (Benitez-Garcia, Nakamura, & Kaneko, 2017). Therefore, the emotion recognition tasks which are based on conventional prototypic expressions that Westerners use to represent the basic emotions with their distinct facial movements would be expected to be different from East-Asian stimuli (Jack, Garrod, Yu, Caldara, & Schyns, 2012). In other words, the stimuli (because they include Westerners portraying emotions) are biased to advantage Westerners. Thus, although Western participants recognised emotional expressions of disgust and anger significantly better than East-Asians, the overall better performance of Westerners should still be queried. I examined this question in the present study by including both Western and Asian stimuli.

### 3) Eye Gaze-Emotion Recognition Correlations

The ability to detect emotion variations is crucial for daily social interactions and determines successful adaptation and social adjustment (Engelberg & Sjöberg, 2004). Consistent with this idea, there is a growing body of research that has correlated age and gender differences in emotion recognition with more general difficulties in the social world. I discuss these relations in more detail below.

### 3.1 Emotion Recognition: Verbosity, Social Gaffes, Lie Detection, and Right-Wing Authoritarianism

Past research has shown that older adults with poorer emotion recognition tend to be more verbose, less able to recognise social gaffes, less able to detect lies and are more likely to have right-wing authoritarian social attitudes than younger adults (Halberstadt, Ruffman, Murray, Taumoepeau, & Ryan, 2011; Ruffman, Murray, Halberstadt, & Taumoepeau, 2010; Ruffman, Murray, Halberstadt, & Vater, 2012; Ruffman et al., 2016). Below, I consider these findings in more detail.

Older adults tend to talk more and wander off-topic more than younger adults. Verbosity is marked by prolonged speech that lacked either coherence or focus (Arbuckle & Gold, 1993). Older adults talk more with the tendency to go off-topic, which could imply that they are less interested in having a conversation or more focused on themselves. Such an inclination towards verbosity is associated with poorer psychological functioning in older adults. Previous research has demonstrated that older men who do worse on emotion recognition tasks than older women, tend to have higher scores for off-topic verbosity, which suggests that older men talk more because they fail to recognise the emotional cues of the listener (Ruffman, Murray, Halberstadt, & Taumoepeau. 2010).

Research has also revealed age differences in faux pas (social blunders) performance, partially caused by age differences in emotion recognition. Older adults are stereotypically depicted as being socially unaware as they show deficits in their abilities to distinguish appropriate from inappropriate social behaviour (faux pas) in public. Compared to younger adults, older adults do worse in differentiating between inappropriate and appropriate behaviour, which was linked to their poorer ability to recognise facial expressions (Halberstadt, Ruffman, Murray, Taumoepeau, & Ryan, 2011).

Likewise, the ability to recognise deception correlated with the ability to recognise emotions. Not only did older adults fare worse than younger adults when adjudicating lies and truths, but they were also worse at detecting lies and were more transparent as liars. Importantly, such age differences were explained by age differences in emotion recognition (Ruffman, Murray, Halberstadt, & Vater, 2012).

Moreover, emotion recognition is a consistent predictor of right-wing authoritarianism (RWA) in older adults. Research showed that older adults tended to have higher degrees of submissiveness to authorities and were aggressive to those whose social ideas deviate from their norms (Ruffman et al., 2016). Although social norms during formative years could have influenced RWA in older adults, researchers noted that worse emotion recognition in older adults mediated these RWA tendencies.

### 3.2 Other Plausible Correlations

Since past research has linked poorer emotion recognition with lesser ability to detect lies, increased verbosity, and more right-wing authoritarianism, it would be useful to investigate whether other correlations exist that could impact older adults' physical and psychological well-being. Depression is, unfortunately, a risk factor for suicide. Given that suicide rates among the older adults are high in most countries and older adults tend to be socially isolated, lonely and depressed (Szanto et al., 2012), it would be beneficial to examine whether poor emotion recognition correlates with depression, loneliness, and psychological well-being.

## 4. Broader Aims

In this section, I consider some of the wider impact my study will have. As previously stated, much research on psychology to date was conducted by researchers from WEIRD societies. Research from different fields has shown evidence of cultural differences. Hence, by comparing the emotion recognition of Westerners and South-East Asians, this study investigates whether past research findings on emotion recognition can be generalised to other cultures. In particular, since direct or excessive gazing at eyes might be considered inappropriate or rude for South-East Asians (Argyle & Cook, 1976), their tendency to gaze less at eyes might mean that they have particular difficulty recognising expressions of anger, sadness, and fear relative to Westerners.

Aside from gaze patterns, the present study might help to shed light on increased suicide rates in older adults. Previous research has revealed that older adults with suicide attempts, made significantly more errors on the Reading the Mind in the Eyes task (Eyes task) and that these attempters had restricted social networks (Szanto et al., 2012). The Eyes task examines a range of complex cognitions, emotions and social relations, leading to the expectation that performance on a basic emotion recognition task might also relate to depression and loneliness. I will examine these novel questions in the present study. Although the suicide rate of older adults has declined, it is still higher than that for younger adults (Fiske, Wetherell, & Gatz, 2009). These older adults had few in-person social contacts and experienced more loneliness than non-suicidal depressed older adults (Teo et al., 2015).

In sum, if such correlations exist, it would be useful for governing authorities as they plan community programs to improve the psychological well-being and tackle aging problems on social isolation, loneliness, and depression in older adults.

**5. Overall Aim and hypotheses**

My overarching goal is to test whether men and women benefit differently from eyes and mouth gazing. The first aim was to determine whether women, even when forced to look at only eyes or mouths of facial expressions, would still perform better than men. I predicted that adult males, particularly older adults, would fare worse than women on emotion recognition, and particularly when given the eyes only. In contrast, males might perform better than women when given only the mouth. The second aim was to explore correlations between emotion recognition and depression, loneliness, and psychological well-being. The third aim was to replicate current studies on emotion recognition of older adults in another culture to examine generalisation effects. For instance, given cultural differences in eyes and mouth looking, it is an open question whether Asian women would benefit from looking at eyes (like European women), and whether Asian men benefit from mouth looking (like European men). Older adults' performance on emotion recognition tasks was compared with younger adults' results, as well as across gender (older men versus older women) and culture (NZ Europeans and SG South-east Asian Chinese).

In sum, I hypothesised the following for age, gender and culture: young would be better than old, women would be better than men, and NZ Europeans (NZers) are better than SG Asian Chinese (SGers) since previous research had shown ethnic origin disparity in emotion recognition (Elfenbein & Ambady, 2002, 2003). Second, I hypothesised that women would have better emotion recognition than men when given full faces and the eyes only stimuli, but that men would do better than women when given mouths only stimuli. Finally, I hypothesised that poor emotion recognition would be linked to loneliness, depression, and reduced psychological well-being.

# 6. Method

## 6.1 Participants

The research participants were recruited from those of European descent residing in Dunedin, New Zealand, and those of Asian Chinese descent living in Singapore. Only those participants who met these research criteria were included in the data examined. Participants consisted of 108 younger males and females ($M_{age}$=20.43 years, $SD$ = 2.26) and 109 older males and females ($M_{age}$=69.88 years, $SD$ = 7.02). Within Dunedin, 54 male and female undergraduates were recruited from the University of Otago, and 56 older adults were recruited from referrals, personal contacts and the Department of Psychology's database of participants. All New Zealand participants were of European ethnicity. Within Singapore, 54 male and female undergraduates from the National University of Singapore participated in the study and were given university course credits for their participation while 53 older men and women, who were recruited via referrals and personal contacts, were given monetary compensation for their travels. All participants were either native or competent English speakers, were mentally sound without a history of stroke and had normal vision or corrected to normal visual acuity. All older adults were literate in English although two NZers did not receive any formal education.

| Education level | N | % |
|---|---|---|
| 0. No formal schooling | 2 | 1.83 |
| 1. Primary school | 2 | 1.83 |
| 2. Some high school | 6 | 5.50 |
| 3. High school diploma | 40 | 36.70 |
| 4. Polytechnic diploma | 8 | 7.34 |
| 5. Some undergrad studies (B.A or B.Sc.) | 22 | 20.18 |
| 6. Post-graduate studies (Master's or PhD) | 29 | 26.61 |
| Total | 109 | |

All older adults were also screened using the Mini-Mental State Examination (MMSE) and only scores greater than 25 out of 30 were included in the data set. Ethics approval for the study was obtained by the respective governing bodies of both countries. All participants were given time to read through the consent form before giving their approval to proceed with the research experiment.

### 6.2 Design: Mixed design

Table 1 includes information about the independent variables in the study.

**Table 1**

**Independent Variables in Study**

| Independent Variables | Levels | Design Type | No. per grp |
|---|---|---|---|
| Participant Age Group | Young vs. Aged | Between subjects | 108, 109 |
| Participant Gender | Male vs. Female | Between subject | 108, 109 |
| Participant Ethnicity | European vs. Asian Chinese | Between subjects | 110, 107 |
| Stimuli Face Region | Full face vs. Eyes vs. Mouths | Within subjects | 36, 36, 36 |
| Stimuli Ethnicity | European vs. Asian Chinese | Within subjects | 54, 54 |
| Stimuli Emotion | Ang/Sad/Fea vs. Dis/Hap | Within subjects | 54, 36 |

In the analyses for emotion recognition, the dependent variable was emotion recognition performance, with an unbiased hit rate (Hu) calculated. Taking into consideration the biases and false alarms pertaining to the responses to the stimuli, the unbiased hit rate (Hu) is the squared result of the ‘emotion recognition correct’ divided by the product of the number of stimuli and the frequency of the chosen emotion (Wagner, 1993). This takes into account both hits (e.g., correctly labelling an angry face as ‘angry’) and false alarms (e.g., incorrectly labelling a sad face as ‘angry’). For the eye-tracking portion of the experiment, the dependent variable was looking duration (sec). Eye tracking was measured *after* presentation of the initial 108 emotion face stimuli, and involved re-presenting the 36 full-face stimuli again (both Chinese and European). A failure to give a response was considered a failure to recognise the emotion.

### 6.3 Stimuli

For the emotion recognition task, the stimuli were 108 photographs comprised of half European and half Asian (Chinese) faces (half male, half female). The European faces were from Ekman and Friesen (1976), and the Asian faces from Chen et al. (2009). Each set of stimuli included the six basic emotions of anger, sadness, disgust, fear, surprise, and happiness. Given consistent evidence that anger, sadness and fear are best recognised from the eyes (Bassili, 1979; Calder et al., 2000; Ebner & Johnson, 2009; Sullivan et al., 2007; Wong et al., 2005), whereas disgust and happiness are best recognised from the mouth, and following Sullivan et al. (2007; 2016), I grouped emotions into (1) anger/sadness/fear and (2) disgust/happiness. Surprise was included to increase task difficulty but was not included in either composite because it is identified equally from the eyes and mouth.

The 36 full-face pictures showed faces against a light-coloured background, with faces spanning vertically from hairline (with foreheads exposed) to the chin, and horizontally the face portion between the left and right ear (see Appendix A). For the 36 “Eyes only” and 36 “Mouths only” pictures of six basic emotions, truncation was made from the bridge of the nose to the upper or lower part of the face using an in-house program written in the R programming language. The eyes-only and mouth-only photographs were taken from the full-face photographs. In other words the emotional content was identical but was either given in the full face, eyes only or mouth only. Photographs were randomly displayed sequentially using Qualtrics, a web-based software for questionnaires and surveys. Each stimulus was randomly presented on a monitor screen that was 192x1080 pixels in resolution.

After giving the participants the 108 items of the emotion recognition task (full faces, eyes only, mouth only), the experimenter gave them the full faces along with eye tracking to determine where they were looking (e.g., at eyes or mouth). For this purpose, a Gazepoint eye-tracker was attached to a Toshiba Notebook with an Intel® Core™ i5-5200U CPU with a processor speed of 2.20GHz and an installed RAM of 8.00GB. The laptop, whose system ran on a 64-bit operating system, x64-based processor, was installed with a Windows 10 Home edition. The same set of 36 full-face pictures used in the emotion recognition task was randomly presented on the laptop’s 15.6 inch display screen (resolution of 1366 X 768 pixels) using the Gazepoint Analysis Professional Edition (v5.1.0) x64 software installed in the notebook.

The three sets of questionnaires incorporated into the web-based survey were the short version of the Becks Depression Inventory (Beck, Rial, & Rickels, 1974), Version 3 of the UCLA Loneliness Scale (Russell, 1996) and the short version of the

Warwick-Edinburgh Mental Well-being Scale (Stewart-Brown et al., 2009) respectively.

### 6.4 Procedure

In the first phase of the experiment, I gave participants items in the following order: the depression questionnaire, 36 emotion recognition items (randomly ordered from the full-face, eyes-only and mouth-only stimuli), the loneliness questionnaire measuring, 36 emotion items, the well-being questionnaire, 36 emotion items.

The second phase of the experiment included the eye tracking. The eye-tracker was calibrated to each participant's eye prior the start of this phase. The participants were given six seconds to label each stimulus to give a verbal response to the emotion presented. To participants who needed a reminder, the labels were included at the side of the computer monitor. The answers were recorded and compared with the actual emotion presented on the screen.

For the younger adults, testing was conducted at a laboratory at the University of Otago in Dunedin, New Zealand or the Psychology laboratory of the National University of Singapore (NUS) in Singapore. Testing for the older adults in Singapore was conducted in participants' preferred venues such as their homes, communal spaces and offices (because it was not possible to test in the university laboratory), and likewise for older adults from New Zealand. To ensure similar experimental conditions for both countries, the same researcher conducted all testing, using the same specifications for the experiment, particularly regarding the screen size, and the eye-tracking equipment.

### 6.5 Methods of data analysis

To analyse emotion recognition and looking duration, I used mixed 2 (Participant Age: young, old) x 2 (Participant Ethnicity: NZ, Singapore) x 2

(Participant Sex: female, male) x 3 (Face Region: full face, eyes, mouth) x 2 (Emotion: anger/sadness/fear, disgust/happiness) analyses of variance (ANOVA). The first three variables were between-subjects variables and Condition was a within-subjects variable. The dependent measure was either the unbiased hit rate (for emotion recognition) or looking duration.

# 7. Results

My results were analysed in four parts. First, I compared the emotion recognition accuracy of older adults to that of the younger adults on average across participants' ethnicity, age group and biological sex. Second, I compared participants' gaze patterns at different face areas (right eye, left eye, nose, mouth, upper and lower regions) with emotion accuracy (see Appendix B). Third, I examined the correlations between emotion recognition and looking duration. Fourth, I examined depression, loneliness, and well-being.

## 7.1 Emotion Recognition Accuracy

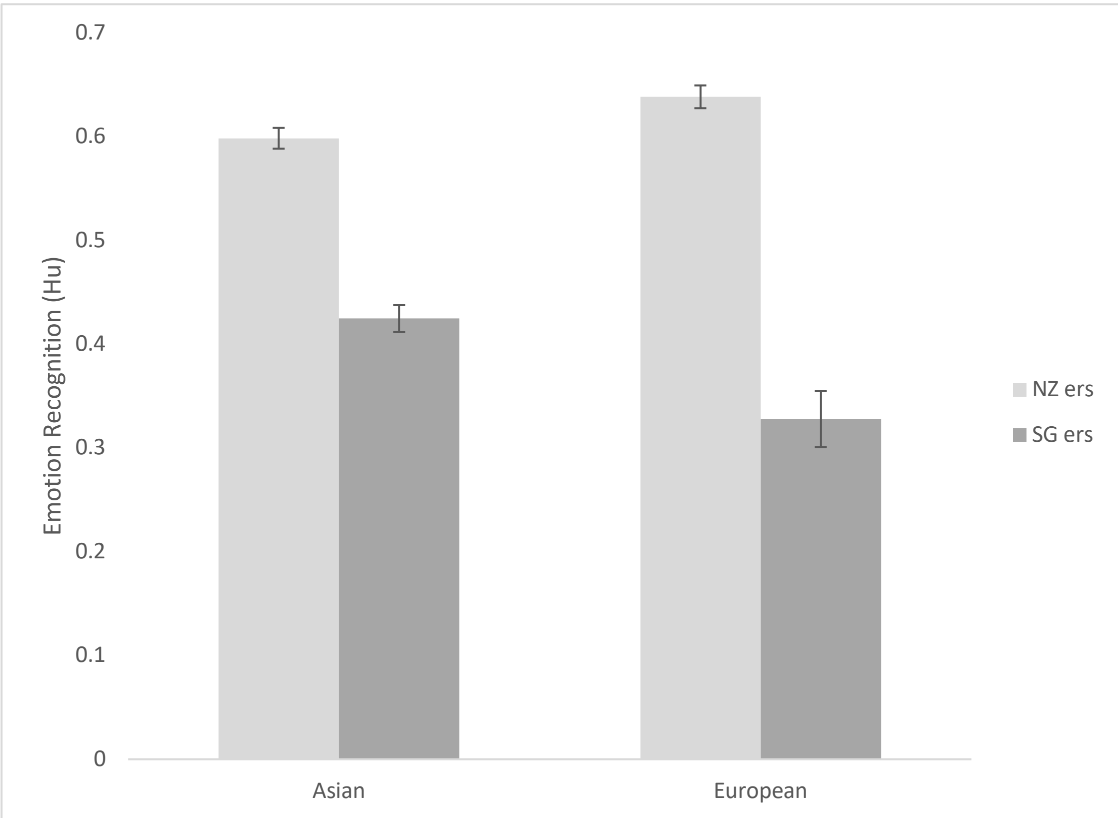
Tables 1a – 1c include the means and standard deviations for emotion recognition (Hu, the unbiased hit rate) for the three face regions (Full Face, Eyes Only and Mouth Only) and broken down according to participant age group, gender and ethnicity.

**Preliminary analysis**

First, I examined whether there was an own-race bias in emotion recognition as in previous research (see Figure 1), using a 2 (Stimuli Ethnicity: Asian, European) x 2 (Participant Ethnicity: SGers, NZers) ANOVA. Stimuli Ethnicity was a within-subjects variable whereas Participant Ethnicity was between-subjects. The dependent variable was the unbiased hit rate (Hu) for the two types of emotion stimuli. The main interest was the interaction, which could indicate an own-race advantage in emotion recognition. As anticipated, the interaction was significant, $F(1, 215) = 43.90$, $p < .001$, $\eta_p^2 = .170$, and was examined with two paired-samples *t*-tests. NZ participants were significantly better at recognising emotions in European faces ($M = .639$, $SD = .119$) than Asian faces ($M = .599$, $SD = .102$), $t(109) = 3.47$, $p = .001$. Conversely, SG participants were significantly better at recognising emotions in Asian faces (*M* = .425, *SD* = .138) than European faces (*M* = .328, *SD* = .275), $t(109) = 5.61$, $p < .001$. This confirmation of previous findings is reassuring in that it indicates there is nothing unusual about the present sample or stimuli. Having established this fact, I dropped Stimuli Ethnicity from subsequent analyses given that I had no further hypotheses regarding this variable.

**Figure 1**

**Own-Race Bias in Emotion Recognition**




*Note*. Bars are standard errors.

**Table 1a**
**Full-face – Mean Unbiased Hit Rates (*SD*) for Emotion Recognition Correct**

| | New Zealand European (Pakeha) | | | | South-East Asian Chinese | | | |
|---|---|---|---|---|---|---|---|---|
| | Younger Female | Younger Male | Older Female | Older Male | Younger Female | Younger Male | Older Female | Older Male |
| Anger | .83 (.18) | .81 (.15) | .82 (.22) | .72 (.20) | .44 (.42) | .37 (.40) | .31 (.35) | .34 (.35) |
| Sadness | .72 (.18) | .78 (.20) | .72 (.17) | .62 (.18) | .45 (.40) | .39 (.40) | .39 (.39) | .39 (.35) |
| Fear | .61 (.22) | .58 (.22) | .57 (.22) | .42 (.24) | .26 (.29) | .24 (.30) | .20 (.29) | .22 (.26) |
| Disgust | .71 (.20) | .74 (.17) | .80 (.17) | .60 (.25) | .36 (.31) | .26 (.28) | .21 (.25) | .25 (.28) |
| Surprise | .73 (.15) | .70 (.18) | .69 (.19) | .62 (.16) | .41 (.36) | .35 (.34) | .33 (.32) | .36 (.33) |
| Happiness | .99 (.04) | .97 (.08) | .97 (.06) | .94 (.09) | .50 (.45) | .44 (.45) | .45 (.46) | .50 (.46) |
| Average | .77 (.16) | .76 (.17) | .76 (.17) | .65 (.19) | .40 (.37) | .34 (.36) | .32 (.34) | .34 (.34) |

**Table 1b**
**Eyes Only – Mean Unbiased Hit Rates (*SD*) for Emotion Recognition Correct**

| | New Zealand European (Pakeha) | | | | South-East Asian Chinese | | | |
|---|---|---|---|---|---|---|---|---|
| | Younger Female | Younger Male | Older Female | Older Male | Younger Female | Younger Male | Older Female | Older Male |
| Anger | .53 (.17) | .56 (.12) | .54 (.23) | .48 (.15) | .60 (.15) | .56 (.11) | .48 (.16) | .47 (.20) |
| Sadness | .47 (.15) | .43 (.16) | .33 (.15) | .29 (.22) | .43 (.16) | .38 (.13) | .31 (.19) | .28 (.18) |
| Fear | .42 (.19) | .43 (.21) | .38 (.17) | .25 (.17) | .42 (.22) | .38 (.21) | .28 (.19) | .26 (.21) |
| Disgust | .31 (.22) | .26 (.18) | .36 (.22) | .24 (.18) | .32 (.23) | .29 (.25) | .27 (.21) | .17 (.18) |
| Surprise | .38 (.17) | .40 (.15) | .43 (.16) | .36 (.15) | .41 (.18) | .44 (.17) | .39 (.13) | .37 (.14) |
| Happiness | .91 (.15) | .93 (.08) | .86 (.14) | .82 (.18) | .93 (.08) | .82 (.20) | .82 (.16) | .82 (.20) |
| Average | . 50(.18) | .50 (.15) | .48 (.18) | .41 (.18) | .52 (.17) | .48 (.18) | .37 (.17) | .40 (.19) |

**Table 1c**
**Mouths Only – Mean Unbiased Hit Rates (*SD*) for Emotion Recognition Correct**

| | New Zealand European (Pakeha) | | | | South-East Asian Chinese | | | |
|---|---|---|---|---|---|---|---|---|
| | Younger Female | Younger Male | Older Female | Older Male | Younger Female | Younger Male | Older Female | Older Male |
| Anger | .59 (.22) | .66 (.18) | .63 (.20) | .52 (.23) | .32 (.23) | .33 (.24) | .40 (.28) | .32 (.23) |
| Sadness | .44 (.18) | .46 (.18) | .29 (.19) | .34 (.20) | .39 (.16) | .38 (.19) | .26 (.16) | .24 (.16) |
| Fear | .45 (.23) | .39 (.24) | .44 (.26) | .41 (.24) | .14 (.18) | .17 (.28) | .14 (.15) | .10 (.12) |
| Disgust | .49 (.18) | .46 (.20) | .50 (.17) | .43 (.20) | .21 (.17) | .19 (.17) | .22 (.22) | .21 (.21) |
| Surprise | .80 (.16) | .81 (.13) | .78 (.18) | .76 (.18) | .62 (.31) | .60 (.28) | .52 (.27) | .54 (.30) |
| Happiness | .92 (.10) | .90 (.14) | .94 (.12) | .86 (.16) | .62 (.31) | .56 (.26) | .61 (.28) | .64 (.31) |
| Average | .62 (.18) | .61 (.18) | .60 (.19) | .55 (.20) | .38 (.28) | .37 (.24) | .36 (.21) | .34 (.22) |

**Main analyses**

To examine these data further, following Sullivan et al. (2007; 2017), I collapsed anger, sadness and fear into a single, and happiness and disgust into a second. The groupings were based on the fact that (a) anger, sadness and fear pose particular difficulties for older adults (Gonçalves, Fernandes, Pasion, Ferriera-Santos, Barbosa, & Marques-Teixeira, 2018; Hayes, McLennan, Henry, Phillips, Terrett, Rendell, Pelly, & Labuschagne, 2020; Ruffman et al., 2008), and (b) anger, sadness and fear are better recognised from the eyes, whereas disgust and happiness are better recognised from mouths (Calder, Young, Keane & Dean, 2000). This meant dropping responses for surprised faces from subsequent analyses, because surprise did not fit neatly into either emotion group.

The data were analysed with a 2 (Participant Age Group: young, old) x 2 (Participant Ethnicity: NZers, SGers) x 2 (Participant Sex: female, male) x 3 (Face Region: eyes only, mouth only, full face) x 2 (Emotion: anger/sadness/fear, disgust/happiness) ANOVA, with the first three variables between-subjects and the last two variables within-subjects. The dependent variable was the mean unbiased hit rate (Hu) for emotion recognition. A summary of the effects from the ANOVA are included in Table 2, with significant effects shown in bold font.

**Table 2**
**Summary of Effects from Analysis of Variance for Emotion Recognition**

| Item | $F$ | $p$ | $\eta_p^2$ |
|---|---|---|---|
| **Face Region** | **26.52** | **<.001** | **.113** |
| Face Region x Participant Age Group | 1.91 | .149 | .009 |
| Face Region x Participant Sex | 0.34 | .710 | .002 |
| **Face Region x Participant Ethnicity** | **97.75** | **<.001** | **.319** |
| Face Region x Participant Age Group x Participant Sex | 0.44 | .957 | .000 |
| Face Region x Participant Age Group x Participant Ethnicity | 0.53 | .529 | .003 |
| Face Region x Participant Sex x Participant Ethnicity | 0.34 | .713 | .002 |
| Face Region x Participant Age Group x Participant Sex x Participant Ethnicity | 1.30 | .273 | .006 |
| **Emotion** | **636.13** | **<.001** | **.753** |
| **Emotion x Participant Age Group** | **18.90** | **<.001** | **.083** |
| Emotion x Participant Sex | 1.07 | .301 | .005 |
| **Emotion x Participant Ethnicity** | **36.22** | **<.001** | **.148** |
| Emotion x Participant Age Group x Participant Sex | 1.65 | .201 | .008 |
| Emotion x Participant Age Group x Participant Ethnicity | 0.37 | .545 | .002 |
| Emotion x Participant Sex x Participant Ethnicity | 0.17 | .682 | .001 |
| Emotion x Participant Age Group x Participant Sex x Participant Ethnicity | 1.04 | .310 | .005 |
| **Face Region x Emotion** | **24.18** | **<.001** | **.104** |
| Face Region x Emotion x Participant Age Group | 0.55 | .577 | .003 |
| 3Face Region x Emotion x Participant Sex | 0.33 | .720 | .002 |
| **Face Region x Emotion x Participant Ethnicity** | **10.29** | **<.001** | **.047** |
| Face Region x Emotion x Participant Age Group x Participant Sex | 0.51 | .602 | .002 |
| Face Region x Emotion x Participant Age Group x Participant Ethnicity | 0.77 | .462 | .004 |
| Face Region x Emotion x Participant Sex x Participant Ethnicity | 0.71 | .493 | .003 |
| Face Region x Emotion x Participant Age Group x Participant Sex x Participant Ethnicity | 0.66 | .519 | .003 |
| **Participant Age Group** | **6.50** | **.012** | **.030** |
| Participant Sex | 3.35 | .069 | .016 |
| **Participant Ethnicity** | **141.34** | **<.001** | **.403** |
| Participant Age Group x Participant Sex | 0.32 | .571 | .002 |
| Participant Age Group x Participant Ethnicity | 0.00 | .991 | .000 |
| Participant Sex x Participant Ethnicity | 0.18 | .673 | .001 |
| Participant Age Group x Participant Sex x Participant Ethnicity | 2.31 | .131 | .011 |

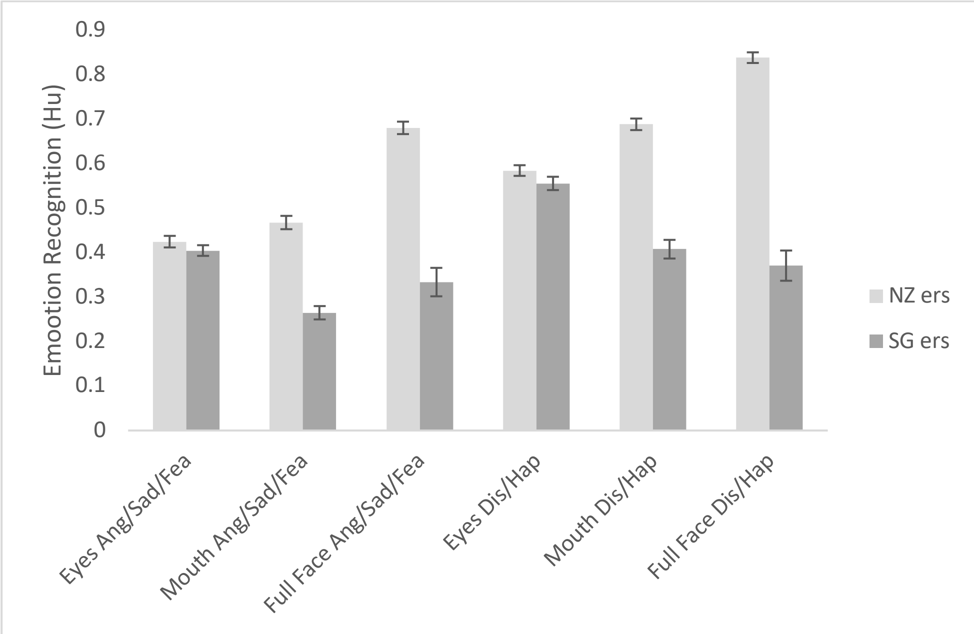
*Note*. Significant effects are in bold text.

**Main effects.** The main effect for Face Region was explored with three paired-samples *t*-tests, indicating better performance on the full-face stimuli ($M = .576$, $SD = .321$) than the eyes only stimuli ($M = .431$, $SD = .142$), $t(216) = 8.95$, $p < .001$ and the mouth only stimuli ($M = .491$, $SD = .175$), $t(216) = 6.05$, $p < .001$. In addition, performance on the mouth only stimuli were better than on the eyes only stimuli, $t(216) = 6.86$, $p < .001$. The main effect for Emotion indicated the performance was better on the disgusted and happy faces ($M = .575$, $SD = .210$) compared to the angry, sad and fearful faces ($M = .424$, $SD = .191$). The main effect for Age Group indicated that young adults ($M = .520$, $SD = .195$) out-performed older adults ($M = .479$, $SD = .195$). Finally, the main effect for Participant Ethnicity indicated that NZers ($M = .619$, $SD = .093$) were much better than SGers ($M = .377$, $SD = .198$).

**Interactions.** There were five significant interactions, including one three-way and four two-ways. The three-way interaction between Face Region, Emotion and Participant Ethnicity (see Figure 2) was examined with two 3 (Face Region) x 2 (Emotion) ANOVAS, one for NZers and one for SGers. The main interest was the interaction. For the NZers, the interaction remained significant, $F(2, 218) = 8.35$, $p < .001$, $\eta_p^2 = .071$, and the same was true for the SGers, $F(2, 212) = 27.02$, $p < .001$, $\eta_p^2 = .203$. The obvious difference was that the interaction effect was larger for the SG participants.

**Figure 2**

**Emotion Recognition When Shown the Eyes, the Mouth or the Full Face**




*Note.* Bars represent standard errors.

The interaction was initially examined three 2 (Emotion) x 2 (Region) x 2 (Participant Ethnicity) ANOVAs. The first ANOVA compared the Mouth Only to the Full Face condition, with an interest in whether the three-way interaction was still significant. In this case, the three-way interaction was not significant, $F(1, 215) = 3.01$, $p = .084$, $\eta_p^2 = .014$. The second ANOVA compared the Eyes Only to the Mouth Only condition and resulted in a significant three-way interaction, $F(1, 215) = 6.89$, $p = .009$, $\eta_p^2 = .031$. The third ANOVA compared the Eyes Only to the Full Face condition. Again, the three-way interaction was significant: $F(1, 215) = 21.99$, $p < .001$, $\eta_p^2 = .093$. Thus, the source of the interaction appears to be the Eyes Only condition for which NZers and SGers performed very similarly, unlike the other conditions in which there was an advantage for NZ Europeans (see Figure 2).

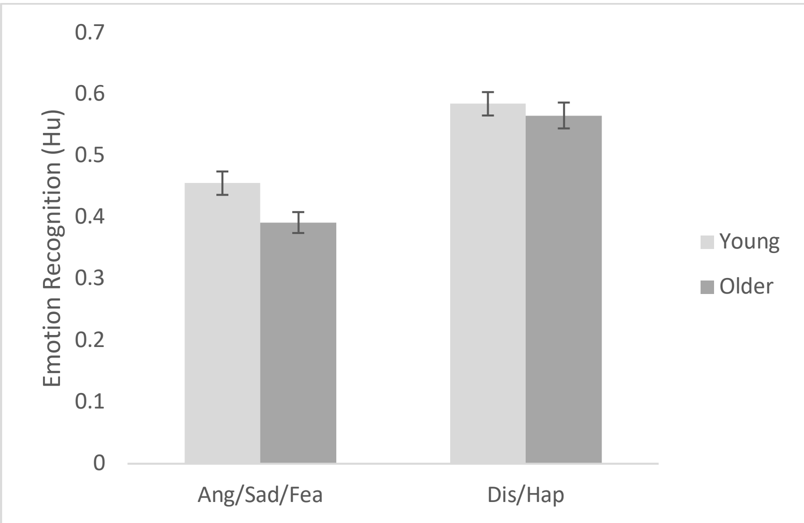
Figure 2 also suggests that whereas the SG participants' performance was best in the Eyes Only Condition, the NZers were worst in this condition (a surprising result). Therefore, the three-way interaction was examined further in two ways. First, I used independent-samples *t*-tests to compare NZers and SGers on each of the six tasks shown in Figure 2, using Holms correction to ensure the family-wise error was kept to $p < .05$. NZers had better recognition of emotion for all tasks, all $t$s(215) ≥ 9.29, all $p$s ≤ .001, with the exception of Eyes Only for anger/sadness fear and disgust/happiness, both $t$s(215) ≤ 1.48, both $p$s ≥ .142.

The second way I explored the interaction was to use paired-samples *t*-tests comparing each pair of tasks (e.g., Eyes Only to Mouth Only, Eyes Only to Full Face, Mouth Only to Full Face) and each emotion group, again using Holm's correction for each family of comparisons. For NZers, all comparisons were significant for anger/sadness/fear, all $t$s(109) ≥ 2.44, all $p$s ≤ .017, with performance best on the Full Face, then the Mouth Only, then the Eyes Only. For SGers, all comparisons were also significant for anger/sadness/fear, all $t$s(106) ≥ 2.16, all $p$s ≤ .033, with performance best on the Eyes Only, then the Full Face, then the Mouth Only. Similar trends were present for disgust/happiness. For NZers, all comparisons were significant, all $t$s(109) ≥ 7.94, all $p$s ≤ .001, with performance best again on the Full Face, then the Mouth Only, then the Eyes Only conditions. For SGers, all comparisons were also significant, all $t$s(106) ≥ 2.01, all $p$s ≤ .047, with performance best on the Eyes Only, then the Mouth Only, then the Full Face. This pattern of results is on the one hand predictable (NZers best with full face), but also surprising (NZers better on the Mouth Only than the Eyes Only condition; SGers better with the Eyes Only than the Full Face).

Of the remaining four (two-way) interactions, three were subsumed by the three-way interaction and were therefore not examined further. Thus, the final interaction was the Emotion x Participant Age Group interaction, which is shown in Figure 3.

**Figure 3**

**Emotion Recognition for Young Versus Older Adults**




*Note*. Bars are standard errors.

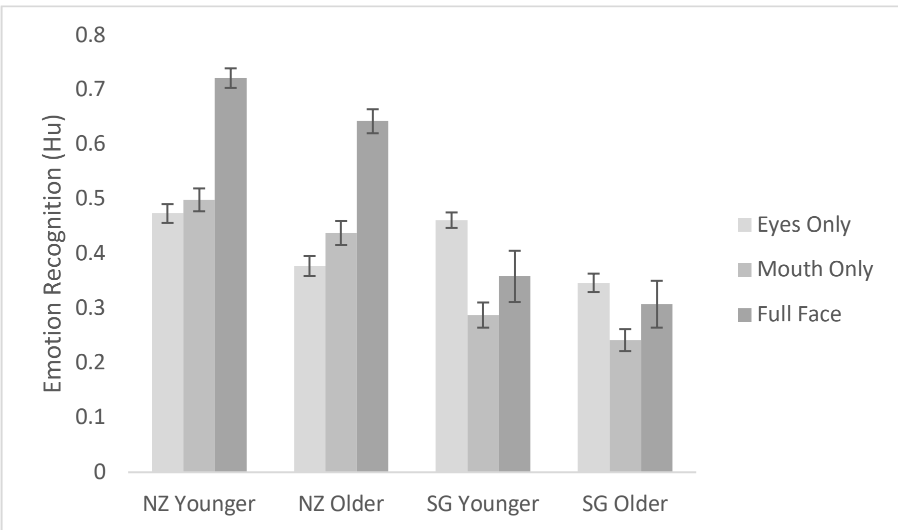
This was examined with tests of simple effects. Consistent with previous research (Ruffman et al., 2008), young adults were significantly better on anger/sadness/fear than older adults, $t(215) = 2.48$, $p = .014$, whereas there was no difference on disgust/happiness, $t(215) = 0.67$, $p = .506$.

A final point of interest with regard to emotion recognition was whether older adults had difficulties relative to young adults when given the eyes only or the mouth only, in addition to when given full faces. Recall that previous researchers have not examined this question but this was an explicit aim of the present study. Given that this was an aim of the present study, I examined this question here with independent-samples *t*-tests comparing anger/sadness/fear recognition from full faces, eyes only and mouths only.

Further, I carried out separate analyses for NZers and SGers given the interest in replicating previous findings for full faces, and that such difficulties have primarily been established with Western individuals (see Figure 4). Within each culture, I used Holm's correction to ensure the family-wise error was kept to $p < .05$. Amongst NZers, young adults were significantly better than older adults on the eyes only stimuli, $t(108) = 3.90$, $p < .001$, full faces, $t(108) = 2.81$, $p = .006$, and for mouths only, $t(108) = 1.99$, $p = .049$. Amongst SGers, young adults were significantly better than older adults on the eyes only stimuli, $t(105) = 5.12$, $p < .001$, but not on full faces, $t(105) = 0.81$, $p = .419$, or mouths only, $t(105) = 1.47$, $p = .143$. In sum, NZ older adults were worse on all three kinds of stimuli, whereas SG older adults were worse only on the eyes. This implies that SG older adults were helped by mouth information (hence eliminating the young advantage) and that they particularly struggled to decipher eyes information.

**Figure 4**

**Emotion Recognition on Eyes Only, Mouth Only and Full Face Stimuli**




*Note.* Bars are standard errors.

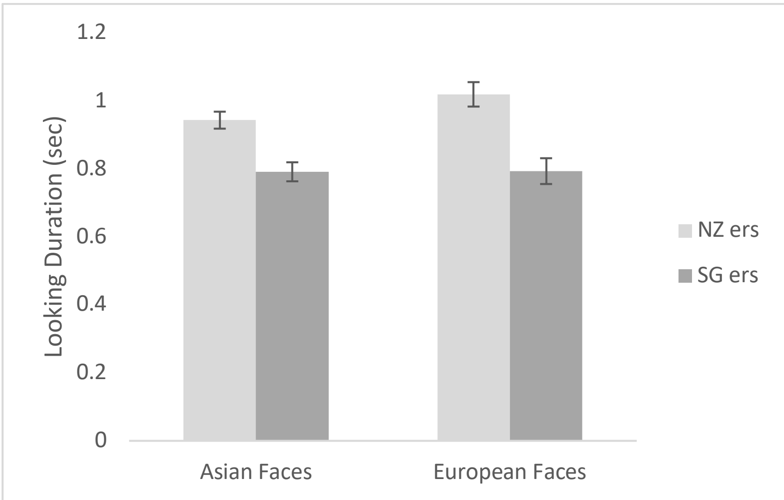
## 7.2 Emotion Recognition with Eye Tracking

### Preliminary analysis

Similar to emotion recognition, I initially examined whether there was an own-race bias for looking duration (see Figure 5).

**Figure 5**

**Looking Duration at Asian and European Faces**




*Note*. Bars are standard errors.

Duration data were examined with a 2 (Participant Ethnicity) x 2 (Stimuli Ethnicity) ANOVA. Stimuli ethnicity was a within-subjects variable and looking duration (in seconds) was the dependent variable. There was a main effect for Stimuli Ethnicity, with participants looking longer at European than Asian stimuli, $F(1, 215) = 11.28$, $p = .001$, $\eta_p^2 = .050$, a main effect for Participant Ethnicity, with NZ Europeans looking longer than SG Asian Chinese, $F(1, 215) = 18.97$, $p < .001$, $\eta_p^2 = .081$, and a significant interaction, $F(1, 215) = 10.14$, $p = .002$, $\eta_p^2 = .045$. The interaction was examined with two paired-samples *t*-tests. NZ Europeans looked longer at European faces compared to Asian faces, $t(109) = 4.70$, $p < .001$, whereas there was no difference in SG participants' looking at European and Asian faces, $t(106) = 0.12$, $p = .904$. Having established these relations, and because I had no further hypotheses about how stimuli ethnicity would interact with other variables, I dropped this variable from subsequent analyses.

**Main Analyses**

This section delves deeper into gaze patterns of the across participants' age group, ethnic origin and biological sex. Table 3 includes the means and standard deviations. The data were analysed with a 2 (Participant Age Group: young, old) x 2 (Participant Ethnicity: NZers, SGers) x 2 (Participant Sex: female, male) x 3 (Face Region: eyes, nose, mouth) x 2 (Emotion: anger/sadness/fear, disgust/happiness) ANOVA, with the first three variables between-subjects and the last two variables within-subjects. The dependent variable was the amount of time (seconds) looking at each region. A summary of the effects from the ANOVA are included in Table 4, with significant effects shown in bold font.

**Table 3**
**Mean Time to View in Seconds (*SD*) and Mean Fixations (*SD*) for Gazing at Emotion Recognition Stimuli (All Emotions)**

| | New Zealand European (Pakeha) | | | | South-East Asian Chinese | | | |
|---|---|---|---|---|---|---|---|---|
| **AOI** ViewType | Younger Female | Younger Male | Older Female | Older Male | Younger Female | Younger Male | Older Female | Older Male |
| **Left Eye** | | | | | | | | |
| TimeViewed | 1.27 (.84) | .59 (.63) | 1.26 (.53) | .60 (.43) | .80 (.78) | .54 (.69) | 1.07 (.53) | .46 (.39) |
| Fixation # | 6.96 (4.94) | 3.11 (3.52) | 7.36 (3.57) | 3.50 (2.73) | 4.13 (3.80) | 3.21 (4.53) | 6.24 (3.67) | 2.70 (2.56) |
| **Right Eye** | | | | | | | | |
| TimeViewed | .80 (.63) | .61 (.67) | .80 (.45) | .68 (.48) | .74 (.53) | .40 (.46) | .66 (.65) | .39 (.39) |
| Fixation # | 4.17 (3.61) | 3.09 (3.51) | 4.38 (2.87) | 3.72 (2.96) | 4.02 (3.19) | 2.03 (2.63) | 3.51 (3.65) | 1.91 (2.09) |
| **Nose** | | | | | | | | |
| TimeViewed | 1.71 (.93) | 1.40 (.91) | 1.79 (.71) | 1.40 (.79) | 1.42 (.70) | 1.06 (.79) | 1.41 (.53) | 1.09 (.79) |
| Fixation # | 12.62 (5.16) | 10.22 (6.59) | 13.61 (4.16) | 11.00 (5.69) | 11.24 (5.20) | 7.74 (6.13) | 10.78 (3.86) | 8.90 (6.56) |
| **Mouth** | | | | | | | | |
| TimeViewed | .47 (.32) | .67 (.59) | .49 (.25) | .58 (.46) | .37 (.38) | .51 (.52) | .40 (.27) | .70 (.61) |
| Fixation # | 1.66 (1.31) | 3.48 (3.67) | 2.33 (1.82) | 3.43 (3.38) | 2.02 (2.66) | 2.91 (4.01) | 1.68 (1.48) | 3.93 (3.68) |
| **Upper** | | | | | | | | |
| TimeViewed | 3.52 (.70) | 2.04 (1.39) | 3.50 (.64) | 2.18 (1.12) | 2.90 (.90) | 1.72 (1.13) | 3.03 (.69) | 1.67 (1.18) |
| Fixation # | 19.56 (3.73) | 11.51 (7.57) | 20.33 (3.18) | 13.68 (6.03) | 16.83 (4.75) | 10.96 (7.52) | 17.69 (3.81) | 10.55 (7.22) |
| **Lower** | | | | | | | | |
| TimeViewed | 1.06 (.55) | 1.46 (1.11) | 1.00 (.56) | 1.38 (1.03) | .97 (.76) | 1.48 (1.08) | 1.00 (.49) | 1.55 (1.13) |
| Fixation # | 5.85 (3.43) | 8.55 (6.30) | 6.00 (3.77) | 8.81 (6.47) | 6.44 (5.16) | 8.62 (6.61) | 5.22 (3.30) | 9.65 (7.24) |
| **Mean** | | | | | | | | |
| TimeViewed | 1.47(.80) | 1.13 (.88) | 1.47 (.52) | 1.14 (.72) | 1.20 (.68) | .95 (.78) | 1.26 (.53) | 1.00 (.75) |
| Fixation # | 8.47 (3.70) | 6.66 (5.23) | 9.00 (3.23) | 7.36 (4.54) | 7.45 (4.13) | 5.91 (5.24) | 7.52 (3.30) | 6.27 (4.89) |

**Table 4**
**Summary of Effects from Analysis of Variance for Looking Duration**

| Item | *F* | *p* | $\eta_p^2$ |
|---|---|---|---|
| **Face Region** | **143.13** | **<.001** | **.406** |
| Face Region x Participant Age Group | 0.01 | .986 | .000 |
| **Face Region x Participant Sex** | **17.64** | **<.001** | **.078** |
| **Face Region x Participant Ethnicity** | **3.67** | **<.026** | **.017** |
| Face Region x Participant Age Group x Participant Sex | 0.04 | .962 | .000 |
| Face Region x Participant Age Group x Participant Ethnicity | 0.48 | .618 | .002 |
| Face Region x Participant Sex x Participant Ethnicity | 0.15 | .862 | .001 |
| Face Region x Participant Age Group x Participant Sex x Participant Ethnicity | 0.54 | .586 | .003 |
| **Emotion** | **9.09** | **.003** | **.042** |
| Emotion x Participant Age Group | 0.24 | .623 | .001 |
| Emotion x Participant Sex | 0.05 | .824 | .000 |
| Emotion x Participant Ethnicity | 0.06 | .802 | .000 |
| Emotion x Participant Age Group x Participant Sex | 0.26 | .608 | .001 |
| Emotion x Participant Age Group x Participant Ethnicity | 0.11 | .736 | .001 |
| Emotion x Participant Sex x Participant Ethnicity | 1.48 | .226 | .007 |
| Emotion x Participant Age Group x Participant Sex x Participant Ethnicity | 0.09 | .760 | .000 |
| **Face Region x Emotion** | **38.49** | **<.001** | **.156** |
| Face Region x Emotion x Participant Age Group | 0.53 | .588 | .003 |
| **Face Region x Emotion x Participant Sex** | **3.88** | **.021** | **.018** |
| Face Region x Emotion x Participant Ethnicity | 1.36 | .257 | .006 |
| Face Region x Emotion x Participant Age Group x Participant Sex | 0.39 | .681 | .002 |
| Face Region x Emotion x Participant Age Group x Participant Ethnicity | 0.81 | .444 | .004 |
| Face Region x Emotion x Participant Sex x Participant Ethnicity | 1.82 | .163 | .009 |
| Face Region x Emotion x Participant Age Group x Participant Sex x Participant Ethnicity | 0.25 | .976 | .000 |
| Participant Age Group | 0.45 | .505 | .002 |
| **Participant Sex** | **18.99** | **<.001** | **.083** |
| **Participant Ethnicity** | **20.31** | **<.001** | **.089** |
| Participant Age Group x Participant Sex | 0.41 | .839 | .000 |
| Participant Age Group x Participant Ethnicity | 0.28 | .596 | .001 |
| Participant Sex x Participant Ethnicity | 0.49 | .486 | .002 |
| Participant Age Group x Participant Sex x Participant Ethnicity | 0.19 | .668 | .001 |

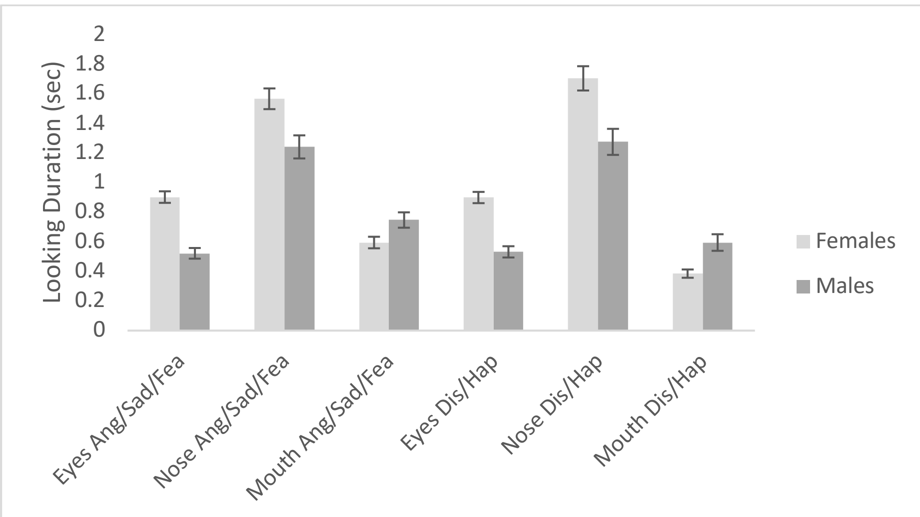
*Note*. Significant effects are in bold text.

**Main effects.** There were four main effects. The effect for face region was examined with three paired-samples *t*-tests. Looking duration was greater toward the nose ($M$ = 1.45, $SD$ = 0.83) than the eyes ($M$ = 0.72, $SD$ = 0.43), $t(216) = 12.22$, $p < .001$, toward the eyes than the mouth ($M$ = 0.58, $SD$ = 0.44), $t(216) = 3.09$, $p = .002$, and toward the nose than the mouth, $t(216) = 13.58$, $p < .001$. The effect for emotion was due to longer looking at the angry/sad/fearful faces ($M$ = 0.93, $SD$ = 0.35) than the disgusted/happy faces ($M$ = 0.90, $SD$ = 0.37). The effect for participant sex indicated that total mean looking time at the face was greater for females ($M$ = 1.01, $SD$ = 0.26) than for males ($M$ = 0.82, $SD$ = 0.40), $t(215) = 4.19$, $p < .001$. The effect for participant ethnicity indicated that mean looking time at the face was greater for NZers ($M$ = 1.01, $SD$ = 0.33) than for SGers ($M$ = 0.81, $SD$ = 0.35), $t(215) = 4.34$, $p < .001$.

**Interactions.** There were four interactions, including one three-way and three two-ways. First, I examined the Face Region x Emotion x Participant Sex interaction (see Figure 6).

**Figure 6**

**Looking Duration at Eyes, Nose and Mouth for Different Emotions**




*Note*. Bars are standard errors.

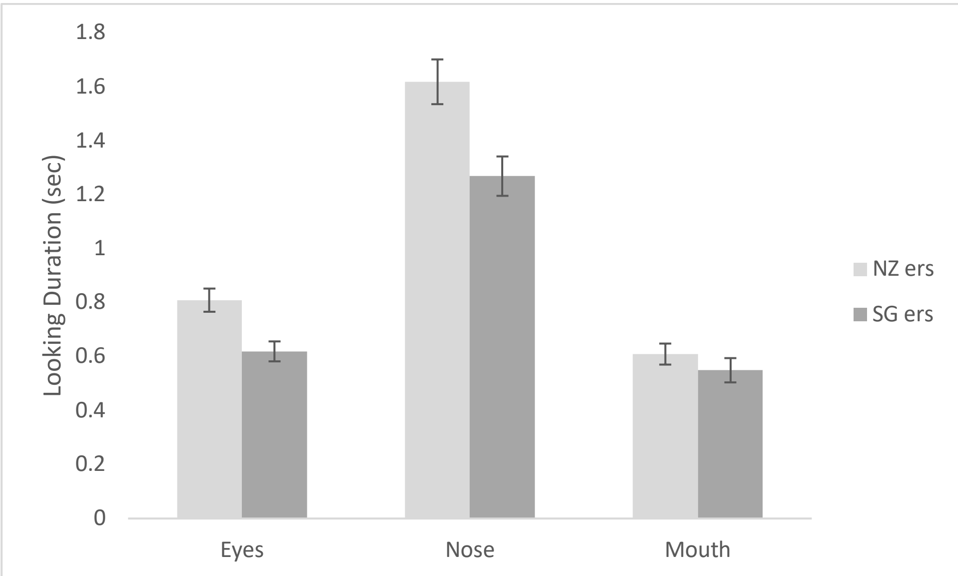
I examined this interaction with three 2 (Face Region) x 2 (Emotion) x 2 (Participant Sex) ANOVAs, comparing looking at each pair of face regions. Of particular interest was the three-way interaction. When comparing looking at noses versus mouths, the three-way interaction was still significant, $F(1, 215) = 5.33$, $p = .022$, $\eta_p^2 = .024$. Likewise, when comparing looking at noses versus eyes, the three-way interaction was still significant, $F(1, 215) = 6.21$, $p = .013$, $\eta_p^2 = .028$. However, when comparing eyes versus mouths, the three-way interaction was not significant, indicating no male/female differences in looking on these two conditions, $F(1, 215) = 0.19$, $p = .662$, $\eta_p^2 = .001$.

Thus, the three-way interaction was examined further by testing whether the Face Region x Participant Sex interaction was significant when comparing mouth and nose looking durations for each emotion, and eyes and nose looking durations for each emotion. The interaction was of particular interest. When comparing looking at mouths and nose for angry/sad/fearful faces, the interaction was significant, $F(1, 215) = 15.54$, $p < .001$, $\eta_p^2 = .067$. The same was true when comparing mouths and nose for disgusted/happy faces, $F(1, 215) = 23.23$, $p < .001$, $\eta_p^2 = .098$. However, when comparing eyes and nose looking for angry/sad/fearful faces the interaction was not significant, $F(1, 215) = 0.41$, $p = .523$, $\eta_p^2 = .002$, and the same was true when comparing eyes and nose looking for disgusted/happy faces, $F(1, 215) = 0.23$, $p = .635$, $\eta_p^2 = .001$. The difference, then, was in male/female looking at faces when comparing the mouth and nose. I examined this difference further with four independent-samples *t*-tests. Females looked longer than males at noses for angry/sad/fearful faces, $t(215) = 3.07$, $p = .002$, and for disgusted/happy faces, $t(215) = 3.18$, $p = .002$, but there was no difference in male/female looking at mouths for either emotion group, both *t*s < 1.06, both *p*s > .292.

Of the three two-way interactions, two were subsumed by the three-way, leaving only the Region x Ethnicity interaction (see Figure 7). This was examined with three independent-samples *t*-tests. NZers ($M$ = 0.81, $SD$ = 0.46) looked more at the eyes than SGers ($M$ = 0.62, $SD$ = 0.38), $t(215)$ = 3.30, $p$ = .001, and more at the nose than SGers (NZers: $M$ = 1.62, $SD$ = 0.87; SGers: $M$ = 1.27, $SD$ = 0.75), $t(215)$ = 31.8, $p$ = .002, but there was no difference in mouth looking (NZers: $M$ = 0.61, $SD$ = 0.41; SGers: $M$ = 0.55, $SD$ = 0.46), $t(215)$ = 0.97, $p$ = .335. This set of results fits with the idea that NZers are more likely to make eye contact than SGers (Uono & Hietanen, 2015)

**Figure 7**

**Looking Duration at Eyes, Nose and Mouth for NZers and SGers**




*Note.* Bars are standard errors.

### 7.3 Correlations Between Emotion Recognition and Looking Duration

Initially, I examined correlations between looking at different face regions for angry/sad/fearful versus disgusted/happy faces. Across all participants, the correlation for looking at these two emotion groups was, $r(215) = .931$, $p < .001$, for the eyes, $r(215) = .935$, $p < .001$, for the nose, and $r(215) = .968$, $p < .001$, for the mouth. Therefore, I collapsed to form one variable each for eyes looking, nose looking and mouth looking.

I then examined the correlations between eyes/nose/mouth looking and emotion recognition for angry/sad/fearful emotions versus disgusted/happy emotions, with a particular interest in patterns for SGers versus NZers (see Table 5). The correlations were very similar for all groups (i.e., (1) young SG females and young NZ females, (2) young SG males and young NZ males, (3) older SG females and older NZ females, and (4) older SG males and older NZ males. Therefore, to increase statistical power I collapsed to form four groups of 50+ individuals: young females, young males, older females, older males. Since this was the same as how Sullivan et al. (2017) examined their data, I carried out the same analysis as they did as one way of helping to examine the contrast with their study.

Tables 6a - 6d show the correlations in these four groups. Of the six possible correlations between (a) eyes looking, nose looking, and mouth looking, and (b) anger/fear/sadness recognition, and disgust/happiness recognition, none were significant for young females. The same was true for young males. In contrast, for older females, more nose looking correlated with better recognition of both anger/sadness/fear and disgust/happiness. For older males, more mouth looking correlated with *worse* recognition of both anger/sadness/fear recognition and disgust/happiness recognition.

**Table 5: Descriptive Statistics and Correlation for Emotion Recognition (Hu) and Ethnic Origin**

| EthnicOrigin | Variable | N | M | SD | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|---|---|---|
| NZ Europeans(Pakeha) | 1. Time looking at Eyes | 110 | 0.81 | 0.46 | - | | | | |
| | 2. Time looking at Noses | 110 | 1.62 | 0.87 | -0.013 | - | | | |
| | 3. Time looking at Mouths | 110 | 0.61 | 0.41 | -0.155 | -0.126 | - | | |
| | 4. Ang/Sad/Fea Emo Recog | 110 | 0.53 | 0.11 | -0.004 | 0.038 | -0.11 | - | |
| | 5. Dis/Hap Emo Recog | 110 | 0.71 | 0.10 | 0.093 | 0.106 | -0.157 | .657** | - |
| South-east Asian Chinese | 1. Time looking at Eyes | 107 | 0.62 | 0.38 | - | | | | |
| | 2. Time looking at Noses | 107 | 1.27 | 0.75 | .289** | - | | | |
| | 3. Time looking at Mouths | 107 | 0.55 | 0.46 | -.233* | 0.107 | - | | |
| | 4. Ang/Sad/Fea Emo Recog | 107 | 0.31 | 0.20 | 0.014 | 0.013 | **-.294**** | - | |
| | 5. Dis/Hap Emo Recog | 107 | 0.44 | 0.21 | -0.02 | -0.009 | **-.283**** | .936** | - |

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

**Table 6a: Descriptive Statistics and Correlation for Emotion Recognition (Hu) for Older Males**

| Participant | Variable | N | M | SD | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|---|---|---|
| Older Males | 1. Time looking at Eyes | 56 | 0.53 | 0.34 | - | | | | |
| | 2. Time looking at Noses | 56 | 1.27 | 0.82 | .497** | - | | | |
| | 3. Time looking at Mouths | 56 | 0.69 | 0.52 | -0.138 | 0.015 | - | | |
| | 4. Ang/Sad/Fea Emo Recog | 56 | 0.37 | 0.17 | 0.145 | -0.053 | **-.315*** | - | |
| | 5. Dis/Hap Emo Recog | 56 | 0.55 | 0.21 | 0.217 | -0.005 | **-.382**** | .896** | - |

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

**Table 6b: Descriptive Statistics and Correlation for Emotion Recognition and Older Females**

| Participant | Variable | N | M | SD | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|---|---|---|
| Older Females | 1. Time looking at Eyes | 53 | 0.93 | 0.31 | - | | | | |
| | 2. Time looking at Noses | 53 | 1.66 | 0.67 | -.333* | - | | | |
| | 3. Time looking at Mouths | 53 | 0.51 | 0.27 | 0.141 | -0.038 | - | | |
| | 4. Ang/Sad/Fea Emo Recog | 53 | 0.41 | 0.19 | 0.081 | **.367**** | 0.068 | - | |
| | 5. Dis/Hap Emo Recog | 53 | 0.59 | 0.23 | 0.13 | **.415**** | 0.13 | .953** | - |

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

**Table 6c: Descriptive Statistics and Correlation for Emotion Recognition and Younger Males**

| Participant | Variable | N | M | SD | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|---|---|---|
| Younger Males | 1. Time looking at Eyes | 52 | 0.53 | 0.41 | - | | | | |
| | 2. Time looking at Noses | 52 | 1.24 | 0.88 | .420** | - | | | |
| | 3. Time looking at Mouths | 52 | 0.65 | 0.53 | -0.165 | 0.192 | - | | |
| | 4. Ang/Sad/Fea Emo Recog | 52 | 0.45 | 0.21 | 0.201 | 0.064 | -0.113 | - | |
| | 5. Dis/Hap Emo Recog | 52 | 0.57 | 0.20 | 0.129 | 0.109 | -0.01 | .929** | - |

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

**Table 6d: Descriptive Statistics and Correlation for Emotion Recognition and Younger Females**

| Participant | Variable | N | M | SD | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|---|---|---|
| Younger Females | 1. Time looking at Eyes | 56 | 0.89 | 0.46 | - | | | | |
| | 2. Time looking at Noses | 56 | 1.61 | 0.87 | -.362** | - | | | |
| | 3. Time looking at Mouths | 56 | 0.47 | 0.35 | -0.075 | -0.051 | - | | |
| | 4. Ang/Sad/Fea Emo Recog | 56 | 0.46 | 0.19 | 0.026 | 0.175 | -0.084 | - | |
| | 5. Dis/Hap Emo Recog | 56 | 0.60 | 0.20 | 0.073 | 0.097 | -0.116 | .935** | - |

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

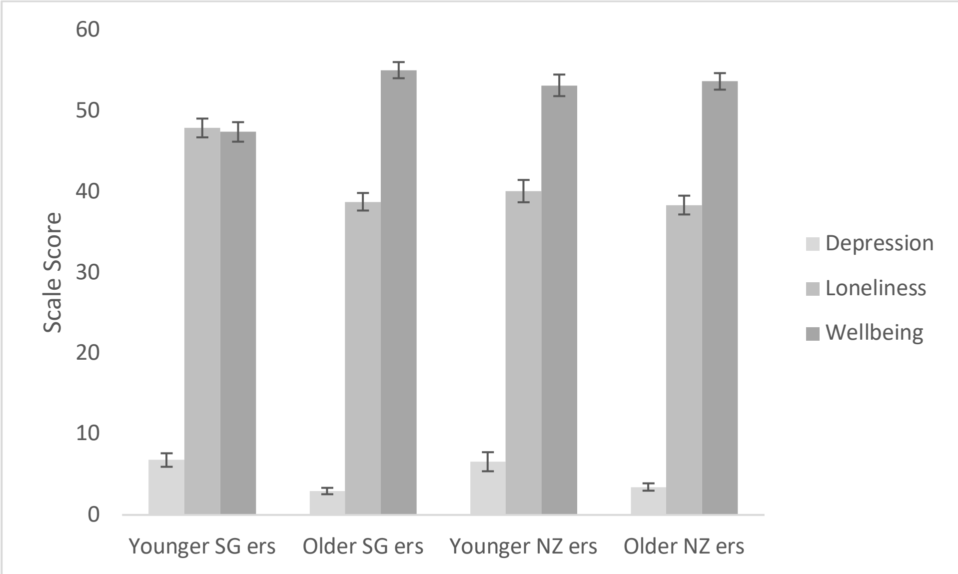
I then compared the two positive correlations for older women with the analogous correlations for older men, and the two negative correlations for older men with the analogous correlations for older women. The correlations between (a) more nose looking and (b) better recognition of anger/sadness/fear and disgust/happiness for older women were both significantly greater than for older men, both $z$s $\geq 2.22$, both $p$s $< .027$. The correlations between (a) more mouth looking and (b) worse recognition of anger/sadness/fear and disgust/happiness for older men were both significantly greater than for older women, both $z$s $\geq 2.00$, both $p$s $< .046$.

**Depression, Loneliness and Wellbeing**

Depression, loneliness and wellbeing were first analysed with a 2 (Participant Age Group) x 2 (Participant Ethnicity) multivariate ANOVA, with depression, loneliness, and wellbeing as the dependent variables (see Figure 8). SGers were significantly lonelier than NZers, $F(1, 213) = 11.66$, $p = .001$, $\eta_p^2 = .052$, although there was no difference in depression or wellbeing, both $F$s $< 2.29$, both $p$s $> .131$. In addition, young adults had higher levels of depression, $F(1, 213) = 19.81$ $p < .001$, $\eta_p^2 = .085$, and loneliness, $F(1, 213) = 20.33$, $p < .001$, $\eta_p^2 = .087$, and a lower level of wellbeing, $F(1, 213) = 15.45$, $p < .001$, $\eta_p^2 = .068$.

**Figure 8**

**Depression, Loneliness and Wellbeing Scores**




*Note*. Bars are standard errors.

In addition, there was an Age Group x Participant Ethnicity interaction for loneliness, $F(1, 213) = 9.42$, $p = .002$, $\eta_p^2 = .042$, and wellbeing, $F(1, 213) = 7.44$, $p = .007$, $\eta_p^2 = .042$, although not for depression, $F(1, 213) = 0.20$, $p = .652$, $\eta_p^2 = .001$. The interaction for loneliness was examined with two independent-samples *t*-tests comparing young and older adults within each culture. There was no difference in loneliness in NZers, $t(108) = 0.96$, $p = .338$, but young SGers were significantly lonelier than older SGers, $t(105) = 5.73$, $p < .001$. A similar trend was present for wellbeing, with no difference for NZers, $t(108) = 0.83$, $p = .411$, but lower well-being in younger SGers, $t(105) = 4.87$, $p < .001$.

Table 7 includes the correlations with emotion recognition (total Hu, across the five emotions). Against expectations, there were no correlations for either group of older adults, and the same was true for young NZers. Only for young SGers were there correlations between worse emotion recognition and higher rates of depression and loneliness.

**Table 7: Descriptive Statistics and Correlation for Emotion Recognition, Depression, Loneliness and Well-being**

| Age Group | | 1 | 2 | 3 |
|---|---|---|---|---|
| Older SGers | 1. Emotion Recognition | - | | |
| | 2. Depression | .249 | - | |
| | 3. Loneliness | .198 | **.385**** | **-** |
| | 4. Well-being | -.059 | **-.288*** | **-.563**** |
| Young SGers | 1. Emotion Recognition | - | | |
| | 2. Depression | **-.319*** | - | |
| | 3. Loneliness | **-.393**** | **.589**** | **-** |
| | 4. Well-being | .162 | **-.689**** | **-.573**** |
| Older NZers | 1. Emotion Recognition | - | | |
| | 2. Depression | -.116 | - | |
| | 3. Loneliness | -.116 | **.646**** | **-** |
| | 4. Well-being | .078 | **-.691**** | **-.574**** |
| Young NZers | 1. Emotion Recognition | - | | |
| | 2. Depression | .011 | - | |
| | 3. Loneliness | .077 | **.570**** | **-** |
| | 4. Well-being | -.081 | **-.745**** | **-.668**** |

*Note*. $^{*}p < .05$, $^{**}p < .01$.

# 8 Discussion

In the present study, I examined how men and women from two different cultures and age groups recognised the basic emotions of anger, sadness, fear, disgust, and happiness. For the first part of my experiment, participants were presented with emotion items showing the full face, eyes only or mouth only. Previous studies examined spontaneous looking at eyes and mouth. Most such studies indicate that older adults look less at the eyes (Birmingham et al., 2018; Chaby, Hupont, Avril, Luherne-du Boullay, & Chetouani, 2017; Sullivan et al., 2007), although one study indicates that young men and women look equally at the eyes whereas older women look increasingly to eyes and older men look increasingly to mouths (Sullivan et al., 2017).

There is also some disagreement as to whether looking assists emotion recognition. On the one hand, one could look longer at a face region because one can't decipher the information (which would result in a negative correlation between looking and recognition). On the other hand, one could look longer at a region, which then assists recognition (which would result in a positive correlation). Sullivan et al.'s (2017) study indicated that looking at mouths is correlated with better recognition of disgust and happiness for men (both younger and older), whereas looking at eyes is correlated with better recognition of anger, sadness and fear for women (both younger and older). It follows, then, that presenting just the eyes should result in good recognition of anger, sadness and fear for women (but not men), whereas presenting just the mouths should result in good recognition of disgust and happiness for men (but not women). Therefore, in my study I presented eyes alone or mouths alone to systematically explore whether older adults could use information in these regions to determine emotion.

For the second part of my experiment, I looked into gazing patterns (looking times) to check whether better emotion recognition was mediated by preferences on specific regions of the face, while comparing across ethnic origin, age group and biological sex. Since previous research on different ethnicities has shown a disparity in emotion recognition (Benitez-Garcia, Nakamura, & Kaneko, 2017; Blais, Jack, Scheepers, Fiset, & Caldara, 2008; Kang & Lau, 2013), but previous studies have also often used Western-biased facial stimuli (Ducci, Arcuri, Georgis, & Sineshaw, 1982; Elfenbein & Ambady, 2002), it was important to examine how NZers and SGers would differ in emotion recognition without Western-biased stimuli. Having described the purpose of my study, below I summarise the findings.

## 8.1 Emotion Recognition

Consistent with my first hypothesis, the preliminary analysis demonstrated that participants from NZ and SG had indeed an own-race advantage in emotion recognition as reported in previous research comparing emotion recognition between Europeans and Asians (Reyes, Segal, & Moulson, 2018). As expected, participants from NZ and SG were better at recognising emotions in stimuli faces from their own ethnic origin. The confirmation of previous findings which showed people were better in recognising emotional expressions from their own gender and ethnic origin (Kang & Lau, 2013), lends confidence that there was nothing unusual about the participants or stimuli used in my research. A second result that lends confidence is that older adults were significantly worse on anger/sadness/fear than young adults.

My results demonstrated better emotion recognition performance when participants were presented with full-face stimuli, followed by the mouth only and the eyes only. However, this main effect was qualified by an interaction such that NZers were best in the Full Face condition but worst in the Eyes Only condition, whereas

SGers were best in the Eyes Only condition (even better than when given full faces). It was surprising particularly that SGers were better in the Eyes Only condition than the Full Faces condition. In other words, both groups were helped by the eyes; NZers because they were better in the Full Face condition than the Mouth Only condition, and SGers because they were better in the Eyes Only condition than either of the other conditions. However, SGers were helped more by the eyes than NZers.

Recall that previous research indicated that anger, sadness and fear are better recognised from the eyes, whereas disgust and happiness are better recognised from the mouth (Bassili, 1979; Calder et al., 2000; Ebner & Johnson, 2009; Sullivan, Campbell, Hutton, & Ruffman, 2017; Sullivan et al., 2007; Wong et al., 2005). The present study obtained a number of consistent findings: (a) SGers identified anger/sadness/fear better from the eyes than the mouth, (b) NZers identified disgust/sadness better from the mouth than the eyes. However, it also obtained a number of contradictory findings: (a) NZers identified anger/sadness/fear better from the mouth than the eyes, (b) SGers identified disgust/happiness better from the eyes than the mouth. Having summarised the findings for emotion recognition, I discuss these in more detail below.

There were some findings that were inconsistent with my hypotheses. Consistent with my first hypothesis, my findings showed that NZ participants out-performed SG participants in emotion recognition. NZ Europeans were more accurate than the South-East Asian Chinese in recognising all emotions from every face region with the exception of anger/sadness/fear from the eyes and disgust/happiness from the eyes. Thus, my results were in line with what previous research had found when comparing emotion recognition between Europeans and Asians (Reyes et al., 2018). One plausible explanation is that learned rules of identifying emotions differ from culture to culture and that Asians tend to express emotions less intensely than Westerners (Biehl et al., 1997; Kitayama, Markus, & Kurokawa, 2000) which could hinder Asians' acumen for emotion recognition. Asian cultures are predominantly influenced by Confucianism (Weiming, T., 2000), which argues for suppressing any public display of emotion (Tombs, Russell-Bennett, & Ashkanasy, 2014). Even loud and hearty laughter is deemed undesirable in a group setting as it reflects that the person is ill-bred. Traditionally, one of the decorums of etiquette observed by women in such cultures is not baring one's teeth and opening mouth wide when laughing. Hence, it is not uncommon to find Asians such as the Japanese, Koreans and the Chinese instinctively covering their mouths when they laugh to avoid showing their teeth. Since an outburst of emotion is generally associated with socially ungracious behaviour in Asian cultures, Asians may have lesser opportunities to learn to identify such emotions. As a consequence, Asians might tend to be weaker in recognising these emotions compared to their European counterparts.

As stated above, surprisingly, when only considering specific face regions, SG participants' performance was best when given the eyes only whereas the NZ participants were worst in this condition. Studies that link the eyes and mouths to the collectivistic or individualistic tendency of a person could offer some insight. Accordingly, people from collectivistic and individualistic cultures differ in their experience of emotions. Chinese participants with a higher collectivistic tendency tend to glean information from the eyes to interpret smiles whereas those from individualistic cultures such as the Europeans tend to be less sensitive and less accurate in using the eyes to interpret smiles (Mai et al., 2011). Other cross-cultural research also showed participants of different ethnic origins adopting different looking strategies in identifying emotions. East Asians supposedly glean salient information that pertains to the eyes by focusing on the centre of the face and eyes to recognise identities and emotions. On the other hand, Western Caucasians tend to switch from eyes to mouths to recognise identities and emotions (Tan, Sheppard, & Stephen, 2015). In their study, although Malaysian Chinese from South-east Asia, appeared to have similar strategies as the Westerners in recognising emotions, their fixation patterns had fewer fixations on the mouths but focused more on the eyes and noses when recognising emotions.

However, in my study, although both NZers and SGers looked more at the nose than the eyes or mouth, NZers looked significantly more at the eyes than SGers and the same was true for the nose (see Figure 7). Thus, there was not the hypothesised increased looking at the nose in the SG culture, at least not compared to NZers.

That younger adults out-performed older adults in the emotion recognition tasks was expected. Previous studies have shown that relative to younger adults, older adults had fewer fixations on the upper region than the lower region of the face (Wong et al., 2005). As a result, older adults who looked less at the eyes than younger adults, and were less accurate in identifying emotions that were easily recognised by looking at the eyes (Sullivan & Ruffman, 2004; Sullivan et al., 2007). These results have implications for the accuracy of emotion recognition should individuals have the tendency to overly focus on either the upper or lower region of the face during social interaction. Consistent with the findings of previous studies (Ruffman, Henry, Livingstone, & Phillips, 2008), my results confirmed the disparity in emotion recognition due to age. In particular, age differences did not significantly affect emotion recognition when participants were presented with the full-face and mouth only stimuli. My findings revealed that regardless of ethnicity origins, younger adults scored higher mean scores than older adults on the anger/sadness/fear stimuli, although for NZers this was true for Full Face, Eyes Only and Mouth Only stimuli, whereas for SGers, it was only true for eyes only stimuli

Previous research also reported that women were better than men in emotion recognition (Sullivan, Campbell, Hutton, & Ruffman, 2017). In the present study, women generally scored higher mean scores than men in emotion recognition tasks. Although I did not find a *significant* main effect for biological sex, there was a trend ($p$ = .069; see Table 2), and given previous findings of a consistent female advantage and that this result is significant on a one-tailed test, I can conclude there was some evidence for a female advantage.

One of the main purposes of the research was to investigate whether men and women benefited differently from eyes and mouth gazing. However, there was no evidence that this was the case. Sex did not interact with Face Region, Age Group or Emotion.

## 8.2 Emotion Recognition with Eye Tracking

The preliminary analysis aimed to examine whether there was an own race bias for looking duration. The main effect for stimuli ethnicity showed longer looking durations for European than Asian faces. NZ participants looked longer at European faces compared to Asian faces whereas there was no difference in SG participants' looking at European or Asian faces. NZers' longer looking duration at European faces appeared consistent with previous research comparing emotion recognition between Europeans and Asians (Reyes et al., 2018). That there was no difference in SG participants' looking at European or Asian faces was puzzling but could perhaps be explained by Singapore's history. Being previously a British colony and a cosmopolitan society, it could be that SGers were used to both Asian and European faces, whereas the NZers were more used to European faces and showed a same-race bias, consistent with findings even for 3-month-olds (Kelly et al., 2005). Without further hypotheses about how stimuli would interact with other variables, I dropped this variable from my subsequent analyses.

The main analyses examined participants' looking patterns and their corresponding emotion recognition correct scores on average across their age group, ethnic origin and biological sex. In particular, I examined whether emotion recognition could be mediated by the amount of time spent looking at each face region. My results revealed that all participants, regardless of ethnicity, gazed longer at the nose region more than the eyes, with NZ participants' eyes and nose looking significantly longer than the SG participants'. Age group did not show any disparity in looking duration, whereas women looked longer at faces than men (see figure 6). Participants also tended to allocate longer looking times at angry, sad and fearful faces compared to disgusted and happy faces. This finding aligns with what previous research had found regarding looking duration (Wells, Gillespie, & Rotshtein, 2016).

The interaction of face region and biological sex was of particular interest and my results indicated that women looked significantly more at the eyes and nose than men, whereas men looked significantly more at the mouth than women. Further analyses revealed that women looked longer than males at noses for angry/sad/fearful faces, and for disgusted/happy faces, but there was no significant difference in women and men looking at mouths for angry/sad/fearful emotion either emotion group. A final difference was that NZers looked longer at the eyes and nose than SGers (see Figure 7).

Conversely, there was no significant difference between NZers and SGers in their mouth looking. These results fit with the notion that Europeans generally have more eye contact in their daily lives than East Asians (McCarthy, Lee, Itakura, & Muir, 2008). Since Europeans are less likely to avert gaze, a greater exposure of visual experience of gaze patterns would inevitably result in a more accurate perception of emotion (Uono & Hietanen, 2015). While it was expected that Europeans would look more at the eyes and nose, one would expect Asian Chinese to look more at noses or mouths since Asians tended to refrain from prolonged direct eye contact, yet Figure 7 shows this was not the case. Generally, in East Asian cultures like Japan, making steady eye contact is deemed as inappropriate when subordinates are talking to their superiors and particularly between men and women. In Chinese societies, which tend to be more authoritative in nature, eye contact can be mistaken as a gesture for defiance. Japanese individuals also rated direct gaze faces as sadder and angrier, finding them more unapproachable and unpleasant (Akechi et al., 2013). Such cultural differences on making eye contact could impact emotion recognition since previous research has shown that avoiding eye regions could disrupt emotion processing of facial expressions (Schurgin et al., 2014; Wegrzyn, Vogt, Kireclioglu, Schneider, & Kissler, 2017).

In sum, my results revealed that NZ and SG participants were looking longer towards the nose than the eyes, spent more time looking towards the eyes than the mouth and looked longer towards the nose than the mouth. Since visual resolution and retinal cell density abate precipitously towards the peripheral visual field, focusing on the centre of the face benefits both NZ Europeans and East Asians as it allows facial elements to be processed globally (Blais et al., 2008). Likewise, previous research also showed that Asian children tended to fixate on the nose region (Kelly et al., 2011). Considered together, these findings helped explain why participants tended to look longer at noses than the eyes.

## 8.3 Emotion Recognition Correlations

Given the cultural differences, disparities in looking patterns are expected, although I note there were also similarities. Perhaps, the real question is how looking relates to emotion recognition. Does increased looking time and a higher number of fixations increase one's ability to recognise emotions? To investigate this question, I examined correlations between eyes, nose, and mouth looking durations with recognition of the two groups of emotions (angry/sad/fearful and disgust/happy) in each culture. There were no correlations between gaze at the eyes, nose or mouth and emotion recognition amongst young males or young females. However, more nose looking correlated with better recognition of anger/sadness/fear and disgust/happiness in older women, and in older men, more mouth looking correlated with *worse* recognition of anger/sadness/fear and disgust/happiness in older men. Clearly, one can look at a face and either *gain* from the looking (explaining the positive correlation in women) or one can look at a face because of difficulty discerning the expression so that longer looking will be associated with *worse* emotion recognition (in men).

My findings extend previous research on how gazing at eyes, noses and mouths affect men and women differently (Sullivan et al., 2017). However, my findings are not entirely consistent with their findings. In part, that might be due to methodology because Sullivan and her colleagues did not include ethnic origin as a variable, nor did they examine the nose on its own. Although I defined the mouth region in a similar way to Sullivan et al., they defined the eyes as including the eye brows and nose ridge between the eyes, whereas in my study, the eyes region did include the eye brows but was specific to the right and left eyes only. Further, the nose was defined as a separate region.

However, these methodological differences cannot explain the different results entirely. For instance, the Face Region x Participant Age Group x Participant Sex interaction was close to 0, indicating that men's mouth looking and women's eyes looking did not differ with age. Nor was better emotion recognition in men correlated with more mouth looking. Indeed, in the present study there was a significant correlation between more mouth looking and *worse* emotion recognition  in older men (the opposite of Sullivan et al.'s finding). In addition, there was no correlation between young men's looking at mouths and emotion recognition (whereas Sullivan et al. found a positive correlation). The reasons for these differences are not clear. A final difference was that neither young or older women's looking at eyes correlated with better emotion recognition, although older women's looking at noses did. Only this last result is explicable by differences in methodology given that the upper part of the nose was included in Sullivan et al.'s eyes region.

I then examined depression, loneliness and wellbeing. That depression and well-being were not correlated with emotion recognition when examining older NZ and SG participants was unexpected. Young SGers had a higher level of depression and a lower level of wellbeing than older SGers. Worse emotion recognition was correlated with higher rates of depression and loneliness amongst young SGers, although there were no correlations with emotion recognition for the measures of mental health for older adults or young NZers. Previous research has associated poorer emotion recognition with faux pas recognition, deception recognition, RWA and verbosity (Halberstadt, Ruffman, Murray, Taumoepeau, & Ryan, 2011; Ruffman, Murray, Halberstadt, & Taumoepeau, 2010; Ruffman, Murray, Halberstadt, & Vater, 2012; Ruffman et al., 2016), but according to my findings, older adults' poor emotion recognition is apparently not related to depression, loneliness or well-being. This could mean that worse emotion recognition affects many general skills and abilities but not older adults' general mood.

Notably, to the best of my knowledge, my study is the only one to examine emotion recognition with the combination of three mental concerns of depression, loneliness and well-being in adults across different ethnic origins. Hence, my research yields new information. Admittedly, correlation cannot be equated with causation and directionality remains ambiguous, further research is warranted to investigate how gazing patterns and mental concerns such as depression, loneliness or well-being impact emotion recognition.

## 9. Limitations and Future Research

Like any study, there are limitations to this research that necessitate further investigations. First, given the unfortunate circumstances of differing societal expectations, university policies and older participants' physical mobility abilities, the experiment was conducted in the homes and offices of the older adults. Although great care was taken by the researcher to ensure compliance of testing to the research specifications, it would be ideal if every experiment was done in the laboratories of the respective universities to ensure uniformity and eliminate potential confounds of differing lighting and environmental distractions of the participants at the time of the experiment. For example, there were instances during the experiment when older participants were distracted by phone calls or called away to attend to their pets. Nevertheless, the emotion recognition data are consistent with previous studies, and therefore do not suggest that the setting for testing affected performance.

Second, due to the aforementioned constraints, older adults were allowed to take their time with the experiment without any pressure to complete the experiment within a given time period. As a consequence, data on precise reaction time specific to each question which would be beneficial for understanding participants' response to each emotion stimuli, could not be collected. The flipside, though, is that older adults' performance was not diminished by time constraints.

In general, all younger participants took under 30 minutes to complete the experiment while all older adults took a longer time, sometimes up to an hour to complete the tasks. Previous research has correlated performance speed, in addition to accuracy as an assessment of clinical deficits. Given that younger adults are faster and fared significantly better than older adults in the emotion recognition tasks, the results suggest that speed could be a mediating factor in emotion recognition performance.

Third, SG is also a WEIRD country which is exposed to different cultures. SG is an affluent and developed country whose citizens were all English-educated under the British system. Needless to say, influences of the Western culture have penetrated deeply into the lives of Singaporeans. Although differentiation of cultural practices is obvious and easily observed, one cannot deny the various similarities in social communication. Over five decades since the independence of Singapore, employers in SG have been strongly encouraging their employees to make consistent eye contact when interacting with customers and business partners in a bid to demonstrate what western cultures depict as friendlier and more sincere interaction. Many Asians who are uncomfortable with direct eye contact have resorted to looking at the eyebrows, noses or other facial features of the person they are speaking to in order to give the impression that they are making eye contact. Such differing social norms might have influenced SGers' gazing pattern.

Fourth, the research did not take into account the "time of day effects" which reportedly affects the cognitive performance of the participants depending on the time of day in which they do the experiment (Maylor & Badham, 2018; Sievertsen, Gino,

& Piovesan, 2016). Since the research was conducted at the participants' convenience, many younger adults who are university students could only participate after their morning lectures or in-between lectures while older adults completed the experiments at various times of the day depending on their schedules. Cognitive fatigue is inevitable and negative affectivity at different times of the day may affect depression, loneliness and well-being scores (English & Carstensen, 2014).

Finally, future research could avoid any geographical confound by also including Asian Chinese participants residing in NZ and NZ Europeans residing in SG in the research.

## 10. Conclusion

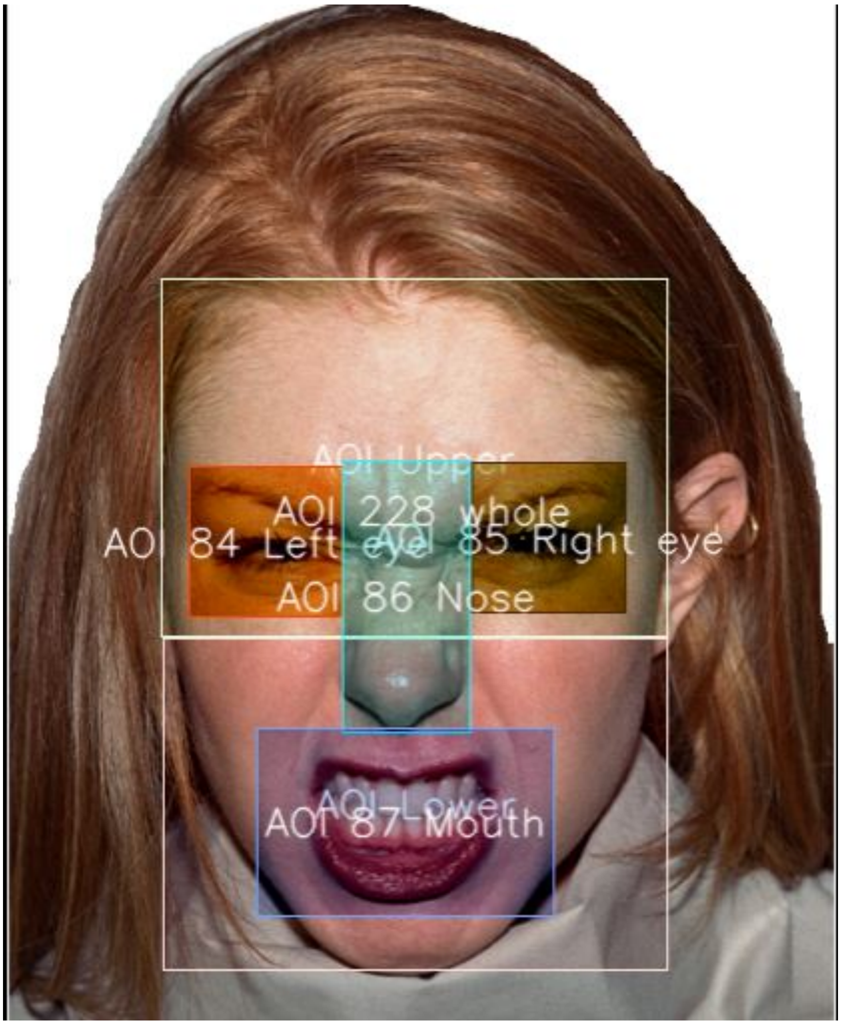
As reviewed, comparing participants across ethnic origin, age and biological sex yielded a more comprehensive understanding of people's emotion recognition abilities. Previous research had illuminated plausible reasons as to why older adults are less efficient in recognising emotions. My research extend upon previous research on emotion recognition and gaze inclinations against a backdrop of differing cultural norms. It becomes increasingly evident that what is studied in one culture may yield conflicting results in another society with differing culture and social norms. Therefore, it is important that what previous studies had found is investigated in another society with different social practices and cultural norms before concluding that previous findings can be generalised to a wider population.

## 11. Appendix A: Eyes only and Mouths only

Eyes only

Mouth only

**Appendix B: AOI regions for Eye Tracking**



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